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Baltimore Community Environmental Partnership Air Committee Technical Report

Community Risk-Based Air Screening:

A Case Study in Baltimore, MD

A Product of the Community Environmental Partnership

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Final Report

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Air Committee Technical Report

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U.S. Environmental Protection Agency
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ACKNOWLEDGMENTS

This report is a summary of work done by the Air Committee of the Baltimore Community Environmental Partnership from 1996 through 1999. The report was prepared by technical staff of the U.S. EPA Office of Pollution Prevention and Toxics for the Air Committee of the Baltimore Community Environmental Partnership. The main EPA authors of the text were David Lynch, Greg Macek, and Hank Topper. The following EPA staff also contributed significantly to the writing of the report and to the work in Baltimore: Ethel Brandt, Damon Brown, James Darr, Deb Forman, Matt Gillen, Todd Holderman, Reggie Harris, Dawn Ioven, Jim Murphy, Nhan Nguyen, Terry O'Bryan, and Van Shrieves.

Members of the Air Committee who contributed to the work in Baltimore are listed in Appendix A. Not all members listed in this appendix participated in the review and approval of this report. The following members of the Air Committee members reviewed, commented on, and approved this report: Suzanne Bond, Pars Ramnarain, and William Paul, Maryland Department of Environment; Don Torres and Rubin Dagold, Baltimore City Health Department; Peter Conrad, Baltimore City Department of Planning; Dr. Michael Trush, Johns Hopkins School of Hygiene and Public Health; Rev. Richard Andrews and Ed Looker, community residents; Dave Mahler, Condea Vista; Rebecca Besson, Delta Chemical; Richard Montgomery, Phoenix Services; John Quinn, BGE; Steve Dyer, Grace Davison; and Charles Nardiello, Arundel Corporation.

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INTRODUCTION

Baltimore Case Study: Risk-Based Air Screening

- Southern Baltimore, Maryland
- Six-Step Risk-Based Air Screening Process Applied to 125 Sources and 175 Chemicals
- Identification of Chemicals of Concern
- Accomplishments and Limitations of Screening Effort

This Baltimore Case Study report describes the work and the results of a risk-based air screening project in Baltimore, Maryland. The report was prepared by technical support staff of the U.S. Environmental Protection Agency's Office of Pollution Prevention and Toxics (OPPT) and Versar, Inc., for the Air Committee of the Community Environmental Partnership (CEP), located in southern Baltimore City and northern Anne Arundel County, Maryland. The introduction to this case study report describes the CEP, the Air Committee, the risk-based screening methodology, and the accomplishments and limitations of the screening effort. Following the introduction are sections that present the application of the six air screening steps to the assessment of air pollution sources in southern Baltimore. These are followed by a summary of the results and lessons learned. The public report that was prepared to communicate the results of the study to the community is included in Appendix J. The results described in that report and this Baltimore Case Study report provide preliminary answers to questions raised by community members about the air quality in their neighborhoods.

This is a case study of the work as it was carried out in Baltimore. The screening methodology described in this report is a work in progress. During the course of the work and in the effort to summarize the work for this case study, the participants in this effort identified many areas for improvement. These are noted throughout the text and summarized in the section on lessons learned. In addition, the case study was reviewed by independent experts in a formal peer review process. Additional suggestions for improvement were developed from these reviews. A summary response to the peer review comments and the comments themselves can be found in the appendices. While recognizing the validity of the suggestion for improvements in the scope and methods of the Baltimore Study, the Partnership Air Committee is confident that the information provided to the community in this report is both significant and valid.

EPA technical staff of the Office of Pollution Prevention and Toxics are now using the suggestions for improvement from the participants and the peer reviewers to develop an improved screening methodology and a "how-to" manual to help communities interested in understanding and improving their air quality. This improved methodology and manual will be available in the spring of 2000. For further information on this work or this case study, please contact the Community Assistance Technical Team of the Office of Pollution Prevention and Toxics. See contact information in the box at end of the Introduction (page 10).

The Community Environmental Partnership

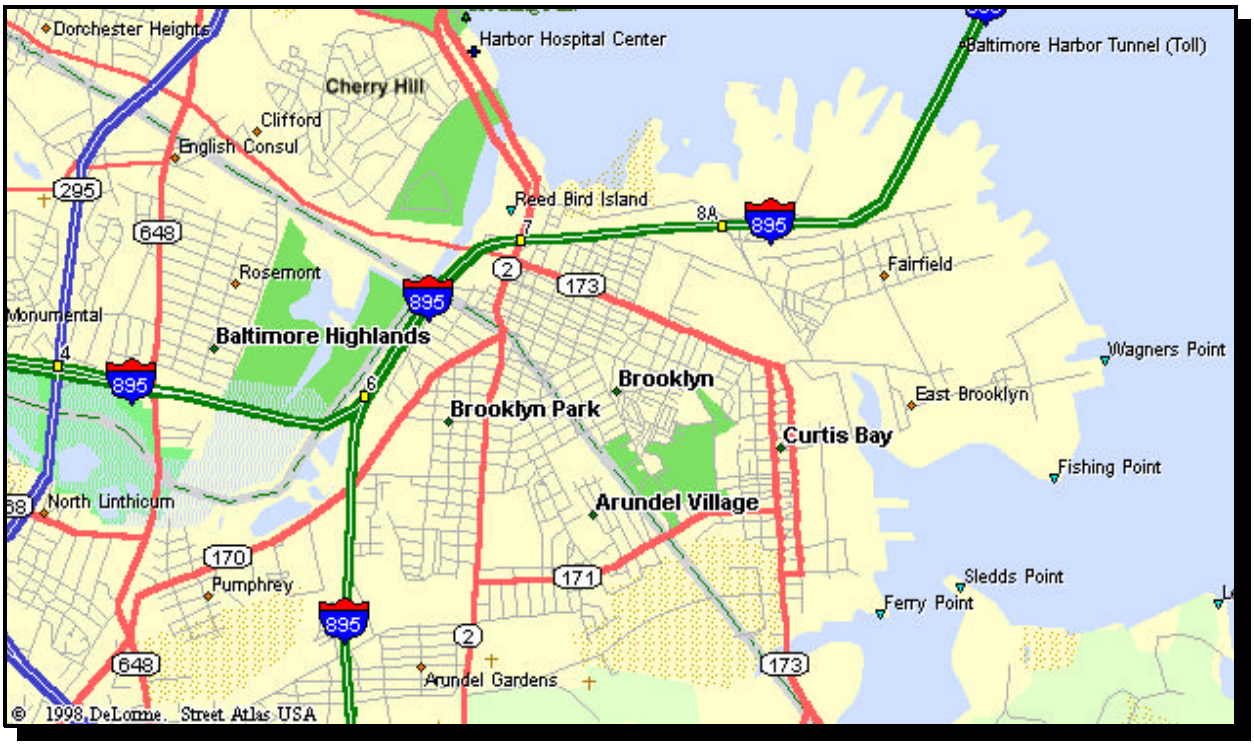
On May 3, 1996, the residents, businesses, and organizations of four Baltimore area neighborhoods—Brooklyn/Brooklyn Park, Cherry Hill, Curtis Bay, and Wagners Point—joined with local, State, and Federal government agencies in the Community Environmental Partnership (CEP) to begin a new effort to find ways to improve the local environment and economy. The five neighborhoods in the Partnership, with a combined population of about 30,000, are located in southern Baltimore City and northern Anne Arundel County (Figure 1). These neighborhoods have a broad range of environmental and economic concerns, including concerns that arise from the concentration of industrial, waste treatment and disposal, and brownfields sites located in and around the Partnership area. The area has great potential for the development of its environmental assets and its economy. The neighborhoods border the Chesapeake Bay and are the site for a new eco-industrial park, a major redevelopment effort that has the potential to attract new jobs. In this context, the Partnership set out to take a comprehensive look at the local economy and environment and to build consensus around a plan for action.

The Community Environmental Partnership started as a pilot for the new community-based approach to environmental protection and economic development.[1] This new approach is an effort to address environmental issues from the perspective of a neighborhood. It incorporates the local community's knowledge and allows for the consideration of a detailed level of information often missed when policy is made at the national or State level. The community-based approach changes the roles of the community and government: It empowers the community to take the lead in the decisions affecting their environment, and it puts government in the role of an adviser, providing the information and technical assistance not available in the community. Building consensus at the local level also makes it possible to unite the community around voluntary pollution prevention approaches that can go beyond current statutory requirements.

Community Environmental Partnership

- Community Residents
- Businesses
- Organizations (Local Schools and the Johns Hopkins School of Public Health)
- Local Government (Baltimore City and Anne Arundel County)
- State Government (Maryland Department of the Environment)
- Federal Government (U.S. EPA)

[1] See EPA's *Framework for Community-Based Environmental Protection*, U.S. EPA. February 1999. EPA 237-K-99-001 (U.S. EPA, 1999a).



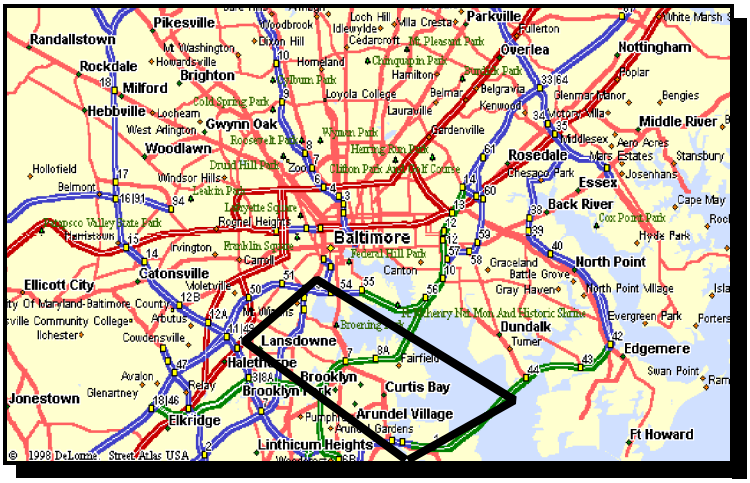


Figure 1. Case Study Area - Baltimore, Maryland

At the beginning of this effort, the partners agreed to focus on the following four goals:

1. Build the long-term capacity of the community, including residents and businesses, to take responsibility for their environment and economy,

2. Develop a comprehensive picture of the local environment and economy and an action agenda based on the needs and wants of the community,

3. Build consensus in the Partnership for the implementation of an action plan that makes a difference in the local environment and economy, and

4. Encourage and support sustainable economic development in the community.

As its first initiative, the CEP conducted a publicity campaign and, in July 1996, held a large public meeting to solicit public input and participation for the project. At this meeting, community residents and businesses discussed and voted on priorities for the Partnership. Five areas were identified as community priorities: (1) air quality; (2) trash, illegal dumping, and abandoned housing; (3) economic development; (4) parks and surface water quality; and (5) community health. Committees were formed to address each of these priorities. This report details the work of the CEP Air Committee. The John Snow Institute is currently preparing a separate report on the overall work of the CEP.

Environmental Setting

Community Key Issues of Concern

- Air Quality
- Trash, Illegal Dumping, and Abandoned Housing
- Economic Development
- Parks and Surface Water Quality
- Community Health

The case study area of southern Baltimore is an industrialized area with a large concentration of industrial, commercial, and waste treatment and disposal facilities. Among these are 11 facilities reporting air emissions to the U.S. Environmental Protection Agency (EPA) Toxics Release Inventory (TRI). Major facilities include an agricultural chemicals manufacturer, other chemical manufacturers, petroleum storage facilities, a medical waste incinerator, the city landfill, and a municipal wastewater treatment plant (publicly owned treatment works [POTW]). Additional facilities, including the city waste incinerator, a large steel mill, and two utility power plants, are located in neighborhoods located close to the Partnership area. More than 175 chemicals are emitted from the facilities in and around the Partnership neighborhoods, such as volatile organic chemicals (VOCs), metals, and others. About 30,000 people reside in the five Partnership neighborhoods of Cherry Hill, Brooklyn, Brooklyn Park, Curtis Bay, and Wagners Point.

The Partnership Air Committee and Goals

Air quality ranked first in the list of concerns voted on at the community's priority-setting meeting. The high interest in air quality was an indication of widespread community concern for the health of residents living in the Partnership neighborhoods and for the possible contribution of outdoor air pollution to the community's health. Community residents were particularly concerned about the possible consequences of the combined emissions from all the industrial, commercial, and waste treatment and disposal facilities located in and around their neighborhoods (See a full description of the pollution sources covered in the Emissions Inventory section on page 19.). In response to community concerns, the CEP Air Committee focused its work primarily on the contribution of air emissions from these types of point and area sources to outdoor air. Although some of the government partners raised the issue of indoor air quality as a topic for consideration, the community did not choose to make this a priority for the CEP Air Committee at that time.

Goals of Air Committee

- To Determine if the Current Aggregate Levels of Toxics in the Air Resulting from the Multiple Industrial, Commercial, and Waste Treatment and Disposal Facilities in and Around the Partnership Area May Affect Community Health
- To Recommend Actions To Improve Community Air Quality

To meet community concerns, the Air Committee set two overall goals for its work: (1) to determine if current levels of toxics in the air in Partnership neighborhoods resulting from the multiple industrial, commercial, and waste treatment and disposal facilities in and around the Partnership area may affect community health; and (2) to recommend actions to improve community air quality. The Committee focused on voluntary participation and voluntary action on the part of its members, with the aim of going beyond regulatory requirements where possible. Compliance, enforcement, and regulatory reform were not the focus for the Air Committee's work. The Committee's work was also done with the view of building the long-term capability of the community to understand and address air quality issues. (See additional discussion of the Air Committee's goals on page 14.)

Air Committee Meetings and Work

The Air Committee held its first meeting in September 1996, and it has continued to meet monthly since that time. Air Committee meetings have consistently drawn around 20 participants. Representation of different sectors of the community on the committee was fairly balanced for most of the Committee's work. Co-chairs, one industry representative and one resident, were elected to lead the Committee work. Four or five residents, one representative of an environmental organization, a faculty member of a local university, six or seven government

representatives, and six or seven business representatives attended the meetings regularly. (See list of Committee participants in Appendix A.) All Committee decisions were made by consensus, and special efforts were made to provide background information and education to ensure full participation by all Committee members. Facilitators were not used to help with the meetings. (During the summer of 1998, after the completion of the screening project but before the release of the results to the public, most community residents and the representative of the environmental organization left this committee. After their departure, the Committee relied on the Partnership's Executive Committee for community representation and direction to complete its work. (See the John Snow Institute case study for a more detailed discussion of the community participation in the Partnership. See also the letters exchanged between the environmental organizations and the Partnership in the summer of 1998 in Appendix B.)

The Baltimore Air Committee began its work by discussing air concerns, conducting an odor survey, and reviewing a report on local TRI releases. The Committee also invited a dioxin expert from EPA to give a presentation. After several months of background preparation, the Committee discussed and agreed on a method to conduct the air screening methodology described in the following pages.

Overview of the Community Air Screening Methodology

As the Air Committee began its work, it soon recognized that to answer community questions about air quality, it would need to find a way to evaluate more than 175 chemicals emitted to the air by more than 125 facilities in or around the Partnership neighborhoods. To complete this review, the Committee decided to develop a risk-based screening methodology that could help to set community priorities. The screening process uses standard methods to provide information on the potential health risks associated with chemicals in the air in Partnership neighborhoods. These methods are consistent with EPA's general guidance on conducting exposure and risk assessments (U.S.EPA, 1989; 1992a). The screening process also builds on established procedures for modeling human health risks from air pollutants, such as *A Tiered Modeling Approach for Assessing the Risks Due to Sources of Hazardous Air Pollutants* (U.S. EPA, 1992b). Using a risk-based approach helps to identify those chemicals that may pose the greatest risks by considering the many factors that influence the potential human health impacts from air pollution sources. For example, the methodology considers factors such as the type of chemical emitted, the quantity emitted, the distance from source to receptors (residents), local wind patterns, and the varying toxicity of the different chemicals.

Air Screening Methodology

- Step 1: Formed Partnership, Clarified Goals
- Step 2: Built Source Inventory Database
- Step 3: Conducted Initial Screening
- Step 4: Conducted Secondary Screening
- Step 5: Conducted Final Screening
- Step 6: Developed Public Report and Recommendations

The Air Committee did not begin its screening work with a completed plan for this methodology in mind. Rather, the Air Committee developed the methodology in a step-by-step fashion in response to the need at each stage of the work. This allowed the screening methodology to be developed in a way that would enable participants to tailor it to the particular needs of the study area. The Air Committee was able to exchange information with similar air inventory and risk assessment projects under way in other EPA offices, such as the Chicago Cumulative Risk Initiative (U.S. EPA, 1999b), the Cumulative Exposure Project (U.S. EPA, 1999c), and the Urban Air Toxics program (U.S. EPA, 1999d). These projects have similar goals of trying to determine exposures and risks from hazardous air pollutants, but they differ from this effort in scope. The methodology described in this report (for the Baltimore area) is still a work in progress. Lessons learned from the experience and areas identified for improvement are provided in the final section of the report. The development and the implementation of the screening work drew on the resources of all Committee members.

To develop a practical screening methodology that could be implemented with limited resources, the Committee used a multistep process. The initial screening used readily available information and simple and protective risk calculations to review the 175 chemicals. In each succeeding step, as the number of chemicals remaining in the screening process decreased, the Committee was able to use more detailed information and more accurate and resource-intensive methods of analysis.

Overall, the Committee's work in Baltimore can be divided into the six steps briefly described below. (See Figure 2 at the end of the introductory section for a flow chart of the air screening methodology.) A more detailed discussion of these steps as they were implemented in Baltimore is provided in the remainder of this report.

- Step 1: Formed Partnership, Clarified Goals

  Formed a broad Partnership committee with representatives from all sectors of the community, including community residents, local businesses, organizations, schools and universities, and local, State, and Federal government agencies. Clarified the goals of the Partnership and developed a plan for work. Also developed an outreach plan to facilitate communication with the community.

- Step 2: Built Source Inventory Database

  Created a community-specific inventory of industrial, commercial, and waste treatment and disposal facility air pollution sources from information available from sources such as emissions permits, compliance records, and the Toxics Release Inventory (TRI). Collected ambient air monitoring data for toxics from stations located in and around the Partnership neighborhoods. Entered these data into a database to facilitate screening.

- Step 3: Conducted Initial Screening

  Screened the inventory using toxicity data and a protective calculation of exposure to identify the chemicals needing further analysis.

- Step 4: Conducted Secondary Screening

  Used computer air dispersion modeling and local meteorological information to get a better estimate of the ambient concentrations for the chemicals selected in the initial screening (Step 3). Compared both modeling and monitoring results to health-based screening values chosen by the Committee. Chemicals with neighborhood concentrations higher than the screening values were identified for further analysis.

- Step 5: Conducted Final Screening

  Contacted the facilities to obtain the most accurate information available on emissions of the targeted chemicals and data pertinent to air dispersion modeling. Conducted the air dispersion modeling again using the refined information. Compared the resulting estimated airborne concentrations and/or monitored air concentrations to the screening guidelines. Chemicals exceeding the Committee screening values were identified as priorities for the community.

- Step 6: Developed Public Report and Recommendations

  Developed recommendations for improving air quality based on the results of the screening exercise and developed a report communicating the results and the recommendations to the community.

Understanding What the Baltimore Risk-Based Screening Effort *Could* and *Could Not* Accomplish

It is important to note up front what the results of the screening analysis could and could not provide to the community. The screening provided valuable information to the community and ***did*** accomplish the following:

- The analysis *did identify and inventory* all the significant commercial, industrial, and waste treatment and disposal sources of toxics in outdoor air in and around the Partnership neighborhoods.

- It *did provide* the best estimates available on the types and amounts of toxics in outdoor air in Partnership neighborhoods from facility sources, including estimates of the aggregate concentrations of the same chemical from multiple sources.

- It *did compare* estimated and measured concentrations to health values and provide enough risk information to help the community set priorities and chart an effective course of action for improving air quality.

- It *did help* to establish a community air quality baseline that can be used to evaluate future progress and to identify potential concerns with new sources.

- It *did allow* the Partnership to compare the levels in its neighborhoods to other urban neighborhoods where concentrations of the same chemical have been measured.

- The collaborative work *did help* to build consensus in the community on air issues and it *did provide* education and information to build community capacity to understand and address air quality issues in the long term.

The information provided from the screening analysis had definite limitations. The screening ***could not*** accomplish the following:

- Most importantly, the analysis *could not* establish the cause of current instances of diseases in the community. Chronic illnesses related to environmental causes may be, in part, due to exposures that occurred many years in the past. This analysis assessed current air quality and, consequently, it provided information on illnesses that could possibly occur in the future, not illnesses that are a result of past exposures. Also, many non-environmental factors that may influence community health were not a part of this analysis. These include factors such as diet, smoking, access to medical care, lifestyle, and genetics. All of these contributing factors need to be considered to effectively address community health concerns.

- Except in some limited cases, this type of screening analysis *could not* provide information on the possible effects of the combined mixture of different chemicals in the air. The science to understand the effects of mixtures of a large number of chemicals does not currently exist.

- The actual risk from these chemicals in each Partnership neighborhood *could not* be determined. This is because (1) much of the screening is based on estimates and not on actual measurement, (2) actual measurements were taken only in a limited number of locations in the Partnership neighborhoods, and (3) a study was not conducted for people living in the Partnership neighborhoods to accurately determine exposures. A detailed exposure study would consider, for example, time spent in the neighborhood, age, time spent outdoors, etc. To collect all information necessary for a more detailed risk analysis would cost more and take longer, and the Committee decided the additional information might not have contributed significantly to the community's ability to set priorities for improving air quality.

- The analysis *could not* provide a complete and comprehensive screen of the hazards associated with the 175 chemicals contained in the Baltimore inventory. Sixty-three of the 175 chemicals did not have readily available toxicity information and could not be included in the analysis. In addition, the toxicity information that was available may be incomplete. New testing, such as the testing for effects on children and for effects on endocrine systems, may identify additional hazards not considered in this analysis. Given the limits of toxicity information currently available, the Baltimore study is a review of known hazards, not all hazards.

- The analysis *could not* provide a complete picture of all aspects of air quality. Three aspects of air quality that may have significant chronic health effects were not a part of this study: ground level ozone, which is a by-product of the reaction of certain chemicals with sunlight; small particulate matter, especially from diesel exhaust; and short-term peak concentrations of certain chemicals that may contribute to health problems such as asthma. The Air Committee has recommended further work in these areas to evaluate their potential effects on the community.

Summary Flow Chart

Figure 2 contains a flow chart with a detailed outline for the six steps of the screening process. The details for each step are explained in the remaining sections of this report. See also the flow chart (Figure 7 on page 73) with modifications based on lessons learned from the Baltimore Case Study.

How to Contact the EPA/OPPT Community Assistance Team

Community Assistance Team
US EPA (7406)
Office of Pollution Prevention and Toxics
401 M Street, SW
Washington, DC 20460
Telephone: 202-260-6750

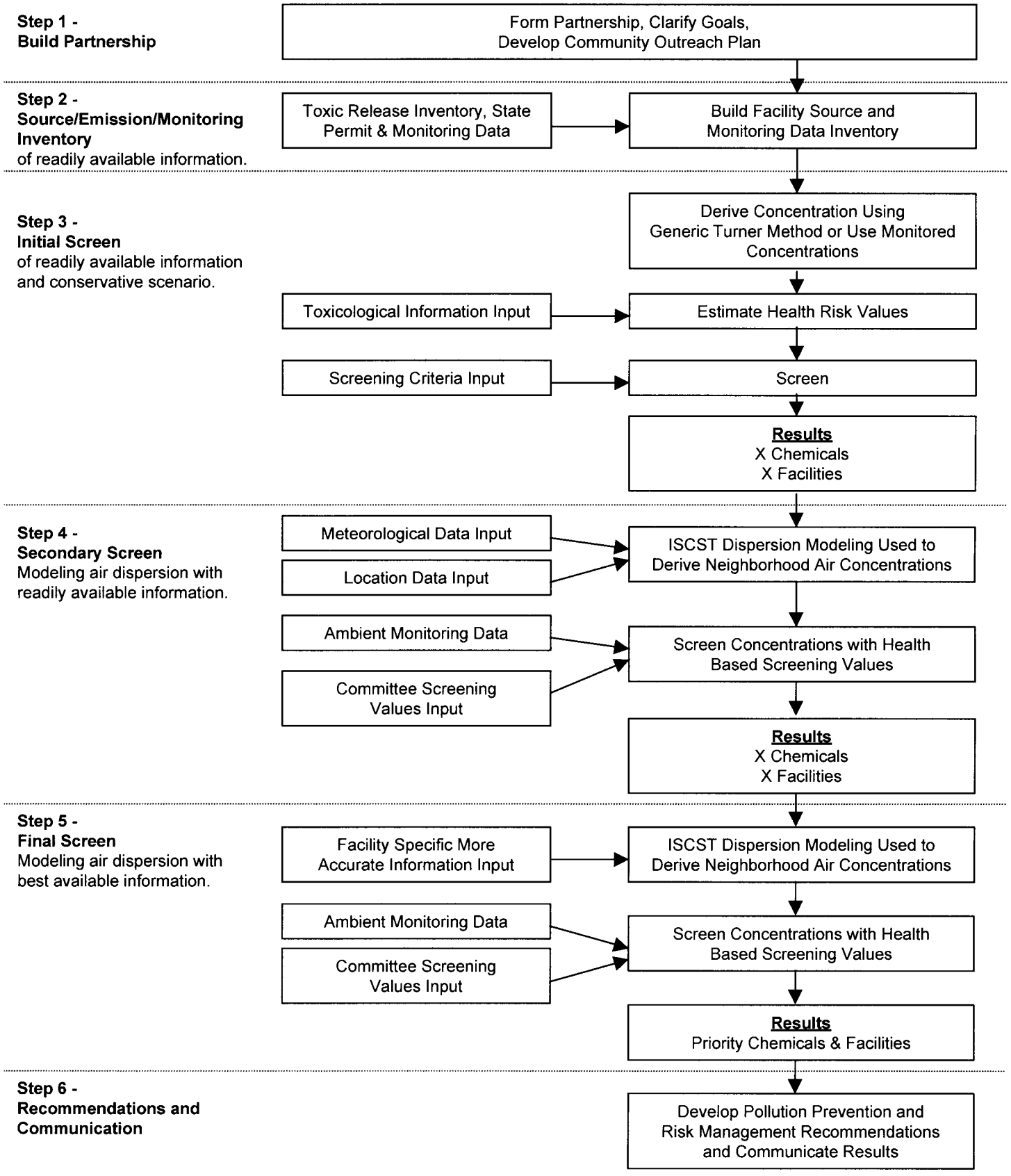


Figure 2. Flow Diagram for Air Screening Methodology

BUILD PARTNERSHIP (STEP 1)

Step 1 - Build Partnership	Form Partnership, Clarify Goals, Develop Community Outreach Plan

This section describes the first step of the air screening exercise carried out by the Air Committee of the Community Environmental Partnership (CEP) in the Baltimore area. Step One included building the Partnership to carry out the work, establishing Committee goals, and developing an outreach plan to communicate the Committee's work to the community.

Formed Partnership

The effort to build a working partnership to address the air quality and other environmental concerns of the neighborhoods of southern Baltimore and northern Anne Arundel County began in the spring of 1995. To form the Community Environmental Partnership, staff and managers from the EPA Office of Pollution Prevention and Toxics (OPPT) met with neighborhood residents, schools, churches, businesses, and local political representatives, including the neighborhood congressional representatives, as well as leaders and staff from the city and county, Maryland Department of the Environment, and EPA Region 3. More than 20 preliminary meetings and briefings were held to explain and consult on the goals and plans for the proposed Partnership. Many of these meetings focused on the question of the potential effect of the Partnership's work on already established efforts to address the concerns of the Partnership neighborhoods. To facilitate government coordination and cooperation in the Partnership, the government partners met biweekly for the first 2 years of the project.

Participants in Community Environmental Partnership

- Neighborhood Residents
- Neighborhood Organizations, Schools, and Churches
- Neighborhood Businesses
- Local Political Representatives, Including Congressional Representatives
- Area Colleges and Universities
- All Levels of Government: City, County, Maryland Department of the Environment, and EPA Region 3 and OPPT

Before the Partnership was established, a local group of businesses and the Baltimore Development Corporation both expressed special concerns. The businesses, represented by the

local Chemical Industry Council, were concerned that a new partnership might upset or duplicate the already established industry and neighborhood relationship. The Baltimore Development Corporation believed that the Partnership might interfere with the city's key brownfields redevelopment plans for an area within the Partnership boundaries. After these concerns were addressed, a consensus acceptable to all the participants was built around a sustainable development approach that considered jobs and a healthy environment. As a part of the consensus-building process, the Partnership visited 50 area businesses to introduce the project and to solicit their support. The positive response to these visits set the stage for the consensus needed for the Partnership. Following a year of discussions and as a culmination of the efforts to reach agreement, all of the partners met in the office of Baltimore's mayor on May 3, 1996, to officially launch the Community Environmental Partnership.

As described in the Introduction, the CEP organized five committees to address community priorities. Air quality was identified as the top priority. More than 60 people from all sectors of the community and all levels of the government participated actively in the work of these committees. Small companies and retail businesses worked primarily on the Economic Development Committee. Students and teachers from local schools and the largest number of residents worked on the Parks and Surface Water Quality and the Trash committees. These committees focused primarily on a project that identified an urban stream flowing into a cove on the Bay shoreline and initiated efforts to restore the stream and use the cove as a community wildlife preserve.

Partnership Priorities

- Air Quality
- Community Health
- Trash, Illegal Dumping, and Abandoned Housing
- Parks and Surface Water Quality
- Economic Development

The Air Committee, with approximately 20 participating members, was the largest committee in the Partnership. The Air Committee met monthly from September 1996 through completion of this report to the community. (A list of regular Air Committee members can be found in Appendix A.) In addition to its regular members, meetings usually drew several additional participants interested in or asked to address a current agenda item.

Clarified Air Committee Goals

The goals for the Air Committee were established in response to the community's concerns for air quality as expressed at the opening public meeting or by the community residents and business members of the Air Committee. The concerns expressed included the following:

- The possibility that the cumulative and aggregate effects of the chemical emissions from the concentration of industrial, commercial, and waste treatment and disposal facilities in and around the Partnership area may be contributing to poor community health, including the possibility that not enough attention was paid in the permitting process to the possible cumulative effects of emissions from multiple facilities. This concern about the possible contribution of emission sources to community health was the main concern expressed by the residents working in the Air Committee.

- The possibility that disease incidence in Partnership neighborhoods, especially the incidence of cancer, are higher than other areas of the city and county. The Health Committee, a separate Partnership committee, was organized to investigate this concern.

- The possibility that unreported emissions may exceed permit levels, especially during weekends or at night. This concern was exacerbated by the frequent occurrence of strong and unidentified odors in some Partnership neighborhoods.

- The possible disproportionate number of waste treatment and disposal facilities sited in the Partnership neighborhoods. Both residents and businesses felt that the reputation and the livability of the community were adversely affected by the large number of waste treatment and disposal facilities. The location of a regional medical waste treatment facility in the Partnership area was a special concern to some residents.

All of these concerns about community health and siting issues were heightened by Baltimore City's plans to focus its brownfields redevelopment efforts on a part of the Partnership area. While the city's plans to attract environmentally responsible companies for an eco-industrial park allayed some concerns, residents and businesses still had concerns about the location of new facilities in the area because the cumulative effects of existing facilities had not been adequately characterized.

In response to these community concerns, the Air Committee decided to focus on the main concern and adopted the following goals:

- To determine if the current aggregate levels of toxics in the air resulting from the multiple industrial, commercial, and waste treatment and disposal facilities in and around the Partnership area may affect community health, and

- To recommend actions to improve community air quality.

Clarified Air Committee Goals

- To Determine if the Current Aggregate Levels of Toxics in the Air Resulting from the Multiple Industrial, Commercial, and Waste Treatment and Disposal Facilities in and Around the Partnership Area May Affect Community Health
- To Recommend Actions To Improve Community Air Quality

The Air Committee's choice of goals narrowed the range of community concerns that would be addressed by the Committee. The Committee concluded that siting of waste treatment and disposal facilities was a local land use issues and not an appropriate issue for the Partnership Committee. In addition, the Committee's focus on potential exposures to toxic chemicals emitted by industrial, commercial, and waste treatment and disposal facilities meant that the Committee did not fully consider other types of potential exposures, including:

- Exposure to toxics from mobile sources, including particulate matter emissions from diesel truck traffic. (The Committee did analyze data from the State ambient air monitoring station located in the Partnership area. The monitored levels represented the aggregate concentrations from all sources including mobile sources. To help explain these monitored concentrations, the Committee estimated the contribution of mobile sources to the level of toxics in outdoor air. This estimation is described in Step 5);
- Exposures to toxics in indoor air; and
- Short-term and peak exposures that might produce acute effects.

The Committee's scope of work also did not include the consideration of additional factors, other than outdoor air toxics, that might affect community health, such as diet, access to medical care, exposure to lead paint, etc. The narrowing of the Committee's focus to an examination of facility emissions and their potential to affect community health was a conscious Committee choice. The choice was made to respond to the concern of some Committee members who felt that the inclusion of other sources of toxics would distract attention from the industrial, commercial, and waste treatment and disposal facility sources that they believed were the main community concern. In general, the Committee accepted this approach and decided that its work would have more credibility if it spoke directly to the main community concern.

The limited scope of the Air Committee's investigation eventually produced a dilemma. The Committee wanted to focus on the facility sources and to develop concrete recommendations to improve community health. However, the limited focus meant that when the Committee completed its work, it might not be in a position to identify the most effective actions to improve

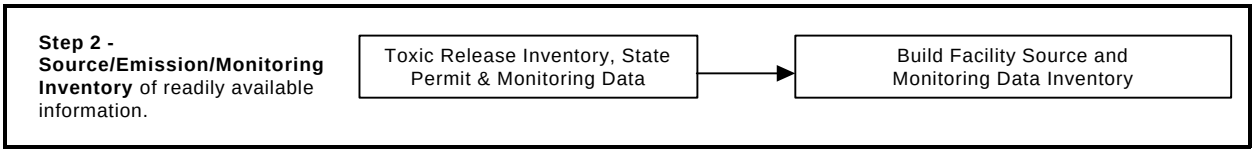
community health. This would be the case if a source of air pollution not included in the study, such as mobile sources, turned out to be a significant source for the community. In fact, when the results of the limited analysis of exposure to facility sources found that these sources were not likely to be a significant contributing factor to community chronic health concerns, the Committee did not have enough information about the other sources to develop the most effective recommendations. (See recommendations in the Air Committee Report, Appendix J.) The possible contradiction between the limited scope of the Committee's work and its ability to make recommendations for the improvement of community air quality and health was not adequately discussed, understood, and agreed to at the beginning of the work.

Developed Plan for Community Outreach

The Coordinating Committee of the CEP asked each of its committees to take 6 months to collect information, develop recommendations, and report back to the Partnership. While the Committee's work proceeded, the Partnership continued its overall outreach efforts. In May 1997, the Partnership opened a community storefront office with environmental information, Internet access, and meeting space. Baltimore Mayor Schmoke joined the community for the opening celebration. In addition, a monthly newsletter describing the progress of the various committees and Partnership was established and sent to more than 300 community members. During its first year, the Partnership organized community cleanups, several educational presentations, and a major Earth Day event.

On April 30, 1997, the Partnership organized its second large public meeting to give the five committees the opportunity to present their findings and recommendations to the community. The Air Committee was not able to complete its screening exercise in time for this meeting; therefore, the Committee presented preliminary results and committed to make a full report at a later date. The screening exercise was completed by the end of 1997. The Air Committee then focused on the production of a report (Appendix J) that could adequately explain and summarize its work for the community. (See discussion of the preparation of this report in Step 6.) Plans are now being made to organize meetings in the community to present and discuss this report.

EMISSIONS INVENTORY (STEP 2)



Overview

To begin its screening analysis, the Air Committee first collected all readily available information relating to local air quality, including information on facility releases and information on concentrations of toxic air pollutants measured at local monitoring stations. The emissions inventory was conducted over a 2-month period by a technical subgroup of the Air Committee, which consisted of representatives from EPA and the Maryland Department of the Environment (MDE). The inventory recorded information on the amounts of chemicals emitted into the air each year by facilities in and around the Partnership area. EPA and MDE reviewed the inventory periodically for completeness and accuracy. The subgroup used a computerized spreadsheet to compile and manage the extensive information.

Emissions and Monitoring Inventory

- Inventory of Emissions Data from 125 Facilities in Area
- Both Emissions Data and Ambient Air Monitoring Data Collected from MDE and U.S. EPA
- Data Organized and Managed Using Spreadsheet That Was Used for All Screening Steps

The emissions inventory included a wide variety of industrial, commercial, and waste treatment and disposal sources of air pollution,[2] ranging from small sources such as gas stations,

[2] Using the terminology of the Clean Air Act, both point (major stationary) and area (small stationary) sources were included in the emissions inventory for this project. Under the Clean Air Act , "point" or "major stationary" sources are stationary facilities that emit a regulated air pollutant in an amount exceeding the threshold level -- 100 or 250 tons per year -- depending on the pollutant and type of facility. Typical major stationary sources include large industrial complexes like power plants, chemical plants, oil refineries, and steel mills. "Area" sources are smaller stationary sources of pollution that are not inventoried individually but whose emissions are estimated as a group and reported as a single source category for a geographic area. Examples of "area sources" include gas stations, dry cleaners, consumer use of solvents, and gas furnaces, fireplaces, and woodstoves which are typically associated with homes and nonindustrial sources.

In the third step of the Baltimore project, air dispersion modeling was used to estimate airborne concentrations of chemicals of concern emitted from industrial, commercial, and waste treatment and disposal facilities. To avoid confusion over terminology, please note that the Clear Air Act definitions for point and area

(continued...)

with annual emissions to air of less than 100 pounds of chemicals, to large facilities with annual emissions of over 1 million pounds. As discussed in Step 1, mobile sources of air pollution such as vehicles, small engines (e.g., lawn mowers and other lawn equipment), combustion products from furnaces, fireplaces, and grills, and ozone and other pollutants emitted or formed in other regions and transported long distances to the Partnership area were not covered in the inventory. Table 1 presents a summary of the types of sources included (and not included) in the inventory for the Baltimore Case Study.

Once the decision was made on the types of facilities to include in the inventory, attention shifted to the process of building the source inventory and finding databases of emissions and monitoring data. This effort benefitted from the knowledge and experience of other EPA programs, such as the Cumulative Exposure Project and the Urban Air Toxics program (U.S. EPA, 1999c and d), as well as on electronic databases maintained by the EPA and MDE (described later in Step 2.)

Sources for Identifying Facilities

A number of information sources were used to identify specific facilities in the Partnership area and to quantify the annual emissions of individual chemicals. ZIP Codes 21225 and 21226 defined the Partnership area. Information was also gathered for facilities located within 5 miles of the Partnership area (ZIP Codes 21060, 21061, 21090, 21122, 21219, 21222, 21227, 21230). As a starting point, the subgroup included all businesses operating in the Partnership area that were listed by Dun & Bradstreet (D&B). Each business was listed by

South Baltimore Partnership Area/Neighborhoods

- ZIP Codes 21225, 21226
- Neighborhoods
  - Cherry Hill
  - Brooklyn/Brooklyn Park
  - Curtis Bay
  - Wagners Point

[2](...continued)
sources described above are not the same as those commonly used in air dispersion modeling. In air dispersion modeling, the terms point and area source have a meaning not related to the amount of the emissions. Point sources have an exact emission site, such as an exhaust stack and they can be both large and small. Area sources, in contrast, cannot be associated with an exact emission site. Area source emissions may come, for example, from evaporation over a large area or from leakage from small multiple locations such as valves. In air dispersion modeling, sources, both large and small, with emissions dispersed across the site are called area sources. Emissions from these sites are modeled as though they were uniformly emitted from the entire area covered by the site. Under the Clean Air Act, all small sources are called area sources regardless of whether their emissions come from an exact point or are dispersed across a site. Thus a small business with an exhaust stack is an area source under the Clean Air Act and a point source in the terminology of air dispersion modeling. Similarly a large source with dispersed emissions, such as a waste treatment facility, would be called a point source under the Clear Air Act and an area source for purposes of air dispersion modeling. Understanding the different use of these terms will be helpful when air dispersion modeling is discussed in step three of the screening methodology.

Table 1. Sources Included and Not Included in the Inventory for the Baltimore Case Study

CAA Category	Included in Baltimore Inventory	Not Included in Baltimore Inventory
Point (major stationary) Examples: chemical plants, power plants, incinerators, landfills, steel mills, POTWs	**X**	
Area (small stationary) (a) Commercial and industrial chemical use and handling Examples: dry cleaners, gasoline stations, print shops	**X**	
(b) Commercial, industrial, institutional boilers Examples: schools, hospitals, office building heating		**X**
(c) Household heating and chemical use Examples: furnaces, fireplaces, lawn chemicals		**X**
Mobile Sources (a) On road Examples: cars, trucks, buses		**X**
(b) Off road Examples: portable generators, construction equipment, boats, lawn mower		**X**

name, type of business, address, telephone number, number of employees, and standard industrial classification (SIC) code (U.S. EPA, 1997a). The subgroup compared this list against a list of facilities permitted by the State of Maryland to emit chemicals to the air, provided by the MDE Air and Radiation Management Administration (ARMA). The list of permitted facilities and the EPA Toxics Release Inventory (TRI) were used to make a master list of facilities that might emit chemicals into the air. The list was then reviewed by:

- Partnership members, including residents familiar with businesses operating in their neighborhoods;
- Chemical engineers familiar with the types of businesses and activities that emit chemicals to the air; and
- MDE staff who were aware of the facilities no longer in operation or whose permits had changed.

Once the final list of facilities operating in and around the Partnership area was obtained, emissions data in pounds per year (lb/yr) were collected and entered in the inventory database. A list of 125 potential facilities was created in this step.

Sources Used To Collect Emissions and Ambient Air Monitoring Data

A variety of database sources were used in compiling the inventory for southern Baltimore. Various government agencies, at local, State, and Federal levels, maintain these databases as part of their compliance monitoring systems. The Air Committee accessed pertinent data sources to obtain data on emissions and concentrations of chemicals in ambient air. The data sources from MDE and EPA are described below. Appendix F contains examples and information on accessing these data sources on the Internet.

Emission Inventory Databases

- Dun & Bradstreet List of Businesses
- Maryland Department of the Environment
  - Registered Stationary Source Emissions
  - Toxic Air Pollutant (TAP) Emissions
- EPA
  - Toxics Release Inventory (TRI)
  - Facility Index System (FINDS)
  - Aerometric Information Retrieval System Facility Subsystem (AIRS/AFS)

Maryland Department of the Environment, Air and Radiation Management Administration

Registered Stationary Source Emissions

Registered source data were provided by MDE. Facilities that are major sources of volatile organic compounds (VOCs), sulfur oxides (SO_x), and nitrogen oxides (NO_x) and facilities with permits to operate were

included in the registered sources emissions inventory. These facilities are required to provide annual emissions data for selected chemicals to the MDE. The chemical emissions reported include certain air toxics and criteria air pollutants (e.g., SO_x, NO_x, particulate matter).

MDE data were later identified by the type of emission (e.g., stack—controlled emissions through an elevated exhaust stack; or fugitive—uncontrolled emissions from leaks and evaporation often near the ground) by EPA and MDE's Air and Radiation Management Administration. These emissions data were entered into a computerized spreadsheet for easier organization and use.

Toxic Air Pollutant (TAP) Emissions

MDE provided TAP emissions data for the most recent year available (1995). MDE collects these data because the State of Maryland developed air toxics regulations for emissions of TAPs not addressed by national or State ambient air quality standards. Carcinogens are "Class I TAPs," and other toxics are "Class II TAPs." Regulations are applicable to any source required to have an air quality permit that discharges a TAP. New construction sources may be required to report TAP emissions, and the source must provide a statement every year that certifies current compliance. A list of TAP chemicals and an example of TAP emissions data for the Partnership area ZIP Codes are included in Appendix F.

Ambient Air Monitoring Data

MDE operates an air monitoring network throughout the State in accordance with EPA guidelines to measure the concentrations of criteria pollutants and selected air toxics in the ambient air. This ambient air monitoring data could be used to represent the concentrations of chemicals in the air that the neighborhood residents breathe. One monitoring station is located in the Partnership area (Fairfield monitoring station). This area is a predominantly industrial zone with significant emissions from chemical manufacturing and petrochemical storage facilities. Five other monitoring sites are located in the Baltimore area (Glen Burnie, Downtown Baltimore, Fort McHenry, Essex, and Northeast Baltimore). The Fairfield monitor, as well as other monitors, are positioned so as to provide readings suitable for estimating exposure over a larger geographic area.

Ambient Air Monitoring Data

- Maryland Department of the Environment
- Ambient Air Monitoring Data for 41 Chemicals from 1992 through 1996
- Five Baltimore Area Monitoring Stations
- Fairfield Monitoring Station Located in Partnership Area
- Use of 1996 Average Concentrations for Risk Screening

Data from 1992 to 1996 for the 41 chemicals monitored, along with their Chemical Abstract Registry (CAS) numbers and details of the MDE monitoring program, are presented in Appendix F. The ambient air monitoring data from the five Baltimore area monitoring stations were compared to the monitoring station in the Partnership area to determine if Partnership area concentrations were significantly higher than other areas around Baltimore. A comparison of the monitored concentrations at the five monitoring sites in the Baltimore area for 1996 is provided in Appendix J.

The trends in air pollutant concentrations for most of the monitored pollutants were steady or downward between 1992 and 1996. In order to use information most relevant to the current levels of chemicals in the air, the Air Committee decided to use monitoring data from 1996 in the screening exercise. Furthermore, annual average concentrations were used for screening because use of maximum values would have probably been too conservative since they were not typical of air quality.

U.S. Environmental Protection Agency (EPA)

Toxics Release Inventory (TRI) Data

EPA collects multimedia chemical release data from selected manufacturing and waste management facilities in the United States (U.S. EPA, 1997b). Certain types of businesses are required to report to EPA on the use and release of about 650 toxic chemicals. The data are compiled in the TRI and are publicly available for use by communities to identify those facilities that release toxic chemicals into the air, water, and other media. Air emissions data, representing both stack and fugitive air emissions estimates, were retrieved from TRI for ZIP Codes 21225 and 21226 (U.S. EPA, 1997b). TRI data for 1994 through 1996 were used when State data were not available. An example of TRI data is shown in Appendix F.

EPA Websites for Air Emissions Data

EPA's Envirofacts Database provides access to several EPA databases that provide users with information about environmental releases to air in the United States. Data sources used for this project included:

- Envirofacts Database: http://www.epa.gov/enviro/index_java.html
- Toxics Release Inventory (TRI): http://www.epa.gov/enviro/html/tris
- AIRS/AFS: http://www.epa.gov/enviro/html/air.html

Aerometric Information Retrieval System Facility Subsystem (AIRS/AFS) Data

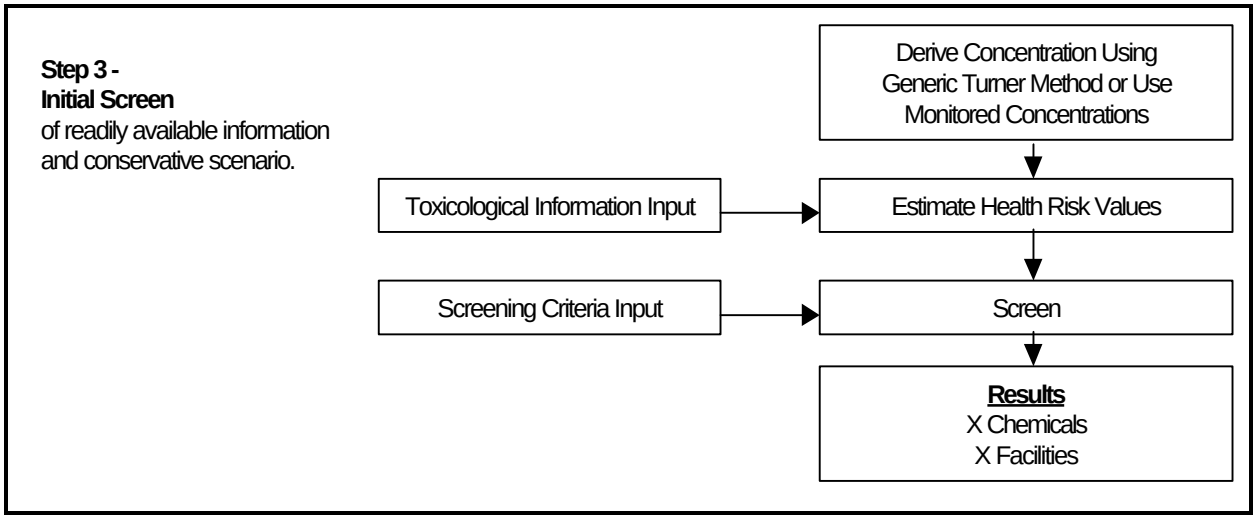
The Aerometric Information Retrieval System Facility Subsystem (AIRS/AFS) contains emissions and compliance data on air pollution point sources regulated by the EPA and/or State

and local air regulatory agencies under the Clean Air Act. AIRS/AFS contains data on industrial facilities, power plants, and similar sources. In general, emissions data are provided for criteria air pollutants (sulfur oxides, nitrogen oxides, particulate matter, carbon monoxide, volatile organic compounds, and lead) and select hazardous air pollutants. Data available for the screening typically represented emissions from inventories conducted in 1995 (U.S. EPA, 1997c).

Database Management

In order to effectively store, manage, and use the data collected, a spreadsheet was created using readily available commercial software (Lotus and Excel). Each database record consisted of a chemical, a facility, an annual emission rate (from the MDE TAP data and from TRI), and other information necessary to calculate exposures and risks. The records also included information such as latitude and longitude of the facilities, emission type (stack or fugitive), stack description, cancer slope factors, and reference doses. (An example of the columns of the database is provided in Appendix G.) Data entry was performed by a number of individuals working on the technical subgroup, and entries were generally checked for errors at least three times. Source documents (hard copy) from which the data were extracted were also maintained as backup for the electronic files.

INITIAL SCREEN (STEP 3)



Overview

Initial Screen

- Use of Source Emissions Data and Generic Turner Method to Predict Air Concentrations
- Estimate of Potential Risk from Inhalation of Chemicals at Predicted Ambient Concentrations
- Comparison of Estimated Risk Against Screening Values
- Identification of 29 Chemicals of Concern

This section describes the application of the initial screening step to emissions sources and monitored concentrations of toxic air pollutants in southern Baltimore. With information on 175 chemicals and 125 facilities assembled in the source inventory database, the Air Committee needed to develop a method to identify which chemicals, if any, might be of concern to the community.

To begin the screening process, the Committee first needed a method to estimate the ambient air concentrations in Partnership neighborhoods that resulted from all the emissions reported in the source inventory. With the large number of chemicals and facilities needing review, the Committee decided that using computer air dispersion modeling to estimate concentrations at this step would require considerable resources. Instead, for the initial screen, the Committee used a simple and protective calculation, described in detail below, to estimate air concentrations. The Committee also included ambient air concentrations measured at the area monitoring station in this initial screen. These estimated and measured ambient air concentrations (concentrations were estimated for 175 chemicals, which included monitored concentrations for 41) were then used to develop

very protective estimates of potential risks to human health from inhalation of these chemicals. The risk estimates for each chemical were then compared to a human health risk-based screening value chosen by the Committee. Any chemicals with risk estimates above the Committee screening value were identified as being of potential concern and were kept in the process for further review. Chemicals with risk estimates below the Committee screening value were eliminated from the screening process. A total of 29 of the 175 chemicals were identified from the initial screen for further review. Details of the process and results are described below.

The Committee designed this initial screening step using conservative assumptions about exposure (i.e., assumptions that tend to overestimate exposure) to make sure that any chemicals that might be of concern were identified for further review. Using conservative assumptions also meant that the Committee could not assume that the chemicals flagged in the initial screen presented a significant risk to the community. More accurate and realistic information was needed to further evaluate potential risks from exposures to these chemicals; therefore, these chemicals were "promoted" to secondary screening where more accurate exposure concentration estimates were developed for risk screening.

Initial Screen Procedures

To complete the initial screen, the Committee entered all information needed to get a screening-level estimate of exposure and risk into the source inventory database. Toxicity information on each chemical was collected and added to the source emissions and monitoring information collected in Step 1. Formulas for calculating conservative ambient air concentrations, exposures, and risks for each chemical were then added to the database, and the calculations were made. The Committee then chose a screening value and compared the calculated risk to the screening value to identify the chemicals that needed further evaluation.[3]

Input from all the Committee members was used to complete this step. Citizens and local businesses verified the accuracy of the source inventory as it was entered into the database. The full Committee participated in the discussion and decision on the choice of screening values and recommended chemicals for further evaluation that were of significant concern to the community for reasons other than the exposure or risk calculations. Government partners provided the air emissions information. Technical experts on the committee assisted with collection of toxicity information, management of the database, and calculations of exposure and risk for the Committee's review. The database was designed to be located in the community so that it could be viewed and updated annually (or more often if warranted).

[3] If risk-based concentrations (RBCs) for the chemicals are available, the estimated air concentrations can be compared directly to the RBCs. This eliminates the need for the risk calculations. For the first step of the screening, the Air Committee did not have access to RBCs. For subsequent steps of the process, described in Steps 4 and 5, the Committee used EPA Region 3 RBCs (U.S. EPA, 1997d).

Technical aspects of the initial screening were designed and carried out in a series of meetings by a subgroup of the Partnership Air Committee. Technical staff from the Johns Hopkins School of Public Health, industry, EPA, and MDE formed the technical subgroup. The subgroup included technical staff with expertise in toxicology, exposure modeling, and risk analysis. EPA provided information on the toxicity of the chemicals in the source inventory, and other Committee members reviewed the information. Building on the source inventory database developed in Step 2, EPA staff added the exposure and risk calculations to the spreadsheet for the screening exercise.

The technical subgroup then held a screening meeting, where chemicals were either dropped or selected for further review. For this review, the spreadsheet was used to sort the inventory by chemical, risk, and quantity emitted. Using this information, Committee members agreed by consensus which chemicals to eliminate from further review and which to move forward for more detailed review in the secondary screening. The actual decision meeting lasted more than 5 hours. Although the meeting was open to all Committee members, community residents did not attend this screening meeting. Residents reviewed the process and results at the next full Air Committee meeting.

Background information on risk screening and additional information on the dose and risk calculations used in the initial screening step are provided below. In this risk screening methodology, the initial screening step developed by the Committee is divided into five separate substeps: (1) collection of toxicity information, (2) estimation of ambient concentrations and potential doses, (3) calculation of cancer risk estimates and hazard quotients, (4) selection of screening values, and (5) comparison of calculated risks and hazard quotients to screening values. These steps are described below following presentation of information on risk screening.

Background Information on Risk Screening

The screening method used by the Air Committee follows the basic risk assessment paradigm developed by the National Research Council (1983):

1. *Hazard identification* is the process of determining whether exposure to a

Risks and Hazards

How estimates of hazard and risk are expressed depends on the nature of the hazard and the types of data upon which the assessment is based. For example, cancer risks are most often expressed as the increased probability of developing cancer for an individual exposed to the chemical in question (i.e., 1 in 1,000,000 or 10^{-6}). Risk estimates for adverse effects other than cancer are usually expressed as the ratio of an estimated dose or exposure level to a toxicologic potency value. This is known as a hazard quotient. A key distinction between cancer and other toxicologic effects is that most carcinogens are assumed to have no dose threshold (i.e., no dose or exposure level can be presumed to be without some risk). Other toxicologic effects are generally assumed to have a dose threshold (i.e., a dose or exposure level below which adverse effects are not expected). But there are exceptions. For example, some carcinogens have thresholds.

chemical can cause an adverse health effect and whether the adverse health effect is likely to occur in humans.

2. *Dose-response assessment* is the process of defining the relationship between the dose of a chemical received and the incidence of adverse health effects in the exposed population. From the quantitative dose-response relationship, toxicity values are derived that are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels.

3. *Exposure assessment* identifies populations exposed to a chemical, describes their composition and size, and presents the types, magnitudes, frequencies, and durations of exposure to the chemical.

4. *Risk characterization* integrates hazard and exposure information into quantitative and qualitative expressions of risk. A risk characterization includes a description of the assumptions, scientific judgments, and uncertainties embodied in the assessment.

Cancer Risk Assessment

Assessment of cancer risks was conducted in a manner that was consistent with EPA's cancer assessment guidelines (U.S. EPA, 1996) and guidance documents such as *Risk Assessment Guidelines for Superfund* (U.S. EPA, 1989). The National Toxicology Program publishes the *Annual Report on Carcinogens* (DHHS, 1994) mandated by the Public Health Service Act. This report lists chemicals "known to be carcinogenic" and chemicals "which may reasonably be anticipated to be carcinogens." Research and regulatory organizations typically employ a "weight-of-evidence" approach to determine the likelihood that a chemical is a human carcinogen. Each chemical evaluated is placed into defined weight-of-evidence categories. For example, EPA (1997e) classifies carcinogens by the five categories listed below[4].

- Group A — human carcinogen
- Group B — probable human carcinogen (B1 indicates limited human evidence; B2 indicates sufficient evidence in animals and inadequate or no evidence in humans)
- Group C — possible human carcinogen
- Group D — not classifiable as to human carcinogenicity
- Group E — evidence of noncarcinogenicity for humans

[4] EPA's guidelines for cancer risk assessment are currently undergoing revision. The proposed guidelines recommend significant changes in the way weight-of-evidence and potency determinations are conducted and expressed. The proposed guidelines emphasize the importance of evaluating the mode of action in the assessment of potential carcinogens.

The International Agency for Research on Cancer (IARC) uses a similar classification scheme:

- Group 1 — carcinogenic to humans;
- Group 2A — probably carcinogenic to humans;
- Group 2B — possibly carcinogenic to humans;
- Group 3 — not classifiable as to carcinogenicity; and
- Group 4 — probably not carcinogenic to humans.

When the available data are sufficient for quantification, estimates of a chemical's carcinogenic potency can be developed. For example, EPA "slope factors" express carcinogenic potency in terms of the estimated upper-bound incremental lifetime risk per milligram per kilogram (mg/kg) average daily dose (U.S. EPA, 1997e). Cancer slope factors (CSFs) are available, where applicable, for both oral (SF_o) and inhalation (SF_i) exposures. "Unit risk" is a similar measure of cancer potency for air or drinking water concentrations and is expressed as risk per microgram per cubic meter ($\mu g/m^3$) in air or as risk per microgram per liter ($\mu g/L$) in water for continuous lifetime exposures.[5] The term "upper bound" in this context means that the measures of cancer potency are high-end estimates, so they will be conservative. This may result in an overestimate of cancer risk when toxicity data are incomplete, which is usually the case. The upper-bound value is intended to be protective of human health for continuous lifetime exposures, even though cancer risk may be overestimated. The use of the average or lower limit values would be more likely to underestimate cancer risk.

Cancer risk is calculated by multiplying the estimated dose by the appropriate measure of carcinogenic potency, the cancer slope factor. For example, an individual with a lifetime average daily dose of 0.03 mg/kg-day of a carcinogen with cancer slope factor of 0.02 $(mg/kg\text{-}day)^{-1}$ would experience an increased lifetime cancer risk of 0.0006 (also expressed as $6 * 10^{-4}$ or 6E-04) from exposure to that chemical. Similarly, cancer risk could be calculated using an air concentration multiplied by the unit risk factor. In general, risks from exposures to more than one carcinogen are assumed to be additive, unless information on interactions points toward a different interpretation.

Risk Assessment for Other Chronic Health Effects

Because adverse effects other than cancer and gene mutations are generally assumed to have a dose or exposure threshold, a different approach is needed to evaluate toxicologic potency and risk for these "systemic effects." The approach for assessing noncancer effects was consistent with EPA's guidelines (U.S. EPA, 1989). "Systemic toxicity" means an adverse effect

[5] Slope factors and unit risks are appropriate measures of carcinogenic potency when the dose-response is thought to be linear. The new proposed guidelines include extensive discussion on the use of a margin-of-exposure or RfD approach for carcinogens in which there is evidence of a nonlinear dose-response or a dose threshold for the carcinogenic response.

on any organ system following absorption and distribution of a toxicant to a site in the body distant from the toxicant's entry point. A measure of toxicologic potency for chronic (long-term) effects is the "reference dose" or "reference concentration." The reference dose (RfD) is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime" and is expressed as a mg/kg-day dose (U.S. EPA, 1997e). The reference concentration (RfC) is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious noncancer effects during a lifetime. Conversion of RfCs to the more traditional RfDs is straightforward using a 20 m^3/day inhalation rate and a 70-kg body weight (U.S. EPA, 1997f). RfD values for inhalation were derived from RfCs and are used in this study. The RfD is usually based on the most sensitive known effect (i.e., the effect that occurs at the lowest dose) and can exist for both oral exposures (RfD_o) and continuous inhalation exposures (RfD_i).[6] Although some RfDs are based on actual human data, they are most often calculated from results obtained in chronic or subchronic animal studies. The basic approach for deriving an RfD involves determining a "no-observed-adverse-effect level (NOAEL)" or "lowest-observed-adverse-effect level (LOAEL)" from an appropriate toxicologic or epidemiologic study and then applying various uncertainty factors and modifying factors to arrive at the RfD. Uncertainty factors are used to derive RfDs and RfCs to account for factors that may alter toxicity. In the absence of sufficient toxicity data to assess risk, the objective is to ensure that estimates are protective of human health, including sensitive subgroups, rather than underestimating the toxicity of chemicals that may pose health risks.

Evaluating risks from chronic exposures to systemic toxicants can be performed using either an RfD or an RfC. An expression of risk called a "hazard quotient" (HQ) is the ratio of the estimated chronic dose to the RfD. Similarly, an HQ can also be calculated as the ratio of the air concentration divided by the RfC. An HQ of greater than 1 would raise a concern. Hazard quotient values below one imply that adverse effects are very unlikely to occur. The greater the extent to which exceeds one, the greater the level of concern. However, it is important to remember that the hazard quotient is not a probabilistic statement of risk (i.e., an HQ of 0.001 does not mean that there is a one-in-a-thousand chance of the effect occurring). Furthermore, it is important to remember that the level of concern does not necessarily increase linearly as the quotient approaches or exceeds unity because the RfD or RfC does not provide any information about the shape of the dose-response curve.

[6] The inhalation reference dose (RfD_i) was used in this case study for evaluating the systemic toxicity of chemicals. A reference concentration (RfC) is another way of expressing the toxicologic potency of a chemical when the exposure is via inhalation.

Collection of Toxicity Information

Sources of Toxicity Data

- Integrated Risk Information System (IRIS)
- Health Effects Summary Tables (HEAST)

To generate the screening-level risk estimates for the chemicals emitted in the Partnership area, the Committee collected toxicity information in the form of cancer slope factors for carcinogenic effects and in the form of inhalation reference doses for other chronic effects. EPA staff collected this information for the Committee and entered it into the source inventory database. EPA's Integrated Risk Information System (IRIS) was chosen as the primary source of toxicity information because of its availability and because of the level of scientific review of the assessments contained in IRIS (U.S. EPA, 1997e). It should be noted, however, that IRIS does not always reflect the most recent data and assessment on a chemical. In the absence of toxicity data for a chemical from IRIS, a secondary source for data used in the assessment was the Health Effects Assessment Summary Tables (HEAST). HEAST (U.S. EPA, 1997f) summarizes published toxicity data and provides estimates of toxicologic potency, but the data in HEAST are not subjected to the same degree of review as those in IRIS. Each source of toxicity data is described in more detail in Appendix D. It should be noted that for the risk calculations, RfDs and slope factors were used. These values were derived from the RfCs and unit risk factors contained in IRIS and HEAST. Conversion of RfCs and unit risks to the more traditional RfDs and slope factors is straightforward using a 20 m^3/day inhalation rate and a 70 kg body weight. Toxicity information for more than 115 of the 175 chemicals was available from these sources. This included 28 chemicals with cancer slope factors and 93 that had RfDs, of which 57 were based on the inhalation pathway. This meant that many, but not all, chemicals could be assessed as part of the screening process.

Calculation of the Air Concentration and Potential Dose

For the initial screen, the Air Committee used the generic Turner method, a standard EPA procedure, to estimate the annual average air concentration and potential dose rate (PDR) for each chemical in the source inventory (Turner, 1994). The generic Turner method was chosen because it is based on a well-known and widely accepted approach in the scientific arena for estimating concentrations of air pollutants emitted from near-ground point sources, and the results can be easily used in a computer spreadsheet. (A description of the generic Turner method is in the text box on the next page.) The initial screen addressed only inhalation exposures to the general population that may result from air emissions from the facilities included in the source inventory. Additional sources and pathways were not addressed in this or subsequent steps of the screening exercise. It should be recognized that persons may also be exposed to certain of the studied chemicals from other sources (e.g., household products, and other pathways such as ingestion of contaminated food, soil, or water).

Calculating Ambient Air Concentration

The following is an example of the use of the generic Turner method in the Baltimore screening analysis to calculate the ambient concentration. The TRI-reported emissions of cadmium in 1994 from SCM/Millennium Specialty Chemicals was estimated as 4 lb/yr. The ambient concentration was estimated as:

Concentration (mg/m^3) = 4 lb/yr * (1kg/2.2lb) * $(4.88*10^{-6})$ = $8.87 * 10^{-6}$ mg/m^3

Calculating Dose

A very conservative estimate of potential dose was calculated assuming a distance of 100 meters from the source, an inhalation rate of 1 m^3/hour, an exposure time of 24 hours per day, an exposure frequency of 365 days per year for a lifetime of 70 years. These assumptions generally do not represent realistic activity patterns; therefore, the potential dose rate estimated is very likely higher than ones actually expected. Additionally, the potential dose represents an estimate of the total quantity of the chemical available for absorption by the specified route, in this case inhalation. The actual absorbed dose can differ significantly from the potential dose, depending on chemical-specific pharmacokinetic and metabolic factors. Using the assumptions above, the ambient concentrations calculated by the generic Turner method were converted to the annual exposure as follows:

Annual exposure (mg/yr) = Q (kg/yr) * 0.043

The procedure for deriving the conversion factor (0.043) for annual exposure shown in the above equation is provided in Appendix E.

The Generic Turner Method

Turner's (1994) sector-averaging form of the Gaussian algorithm can be used to estimate ambient air concentrations that could result from point source emissions. With certain assumptions, a multiple-term equation describing how a chemical released to the air is dispersed and diluted downwind from its source can be simplified as a conversion factor. The assumptions used are as follows:

- A pollutant release height of 3 meters;
- A person exposed 100 meters from the source;
- Neutral atmospheric stability;
- An average wind speed of 5.5 meters per second;
- A continuous release of the chemical; and
- The wind blowing in one direction 25 percent of the time.

Using these assumptions, the ambient air concentrations in units of mg/m^3 can be estimated by multiplying the annual air release (Q) of a chemical in units of kg/yr by a conversion factor. The procedure of deriving this conversion factor ($4.88 * 10^{-6}$) is provided in Appendix E.

Concentration (mg/m^3) = Q (kg/yr) * $(4.88 * 10^{-6})$

This conversion factor ($4.88 * 10^{-6}$) can be incorporated into a computer spreadsheet program that estimates ambient concentrations for all near-ground releases of interest. The ambient air concentration can be compared to an inhalation risk-based concentration. The user also has the option of converting ambient air concentration to annual exposure. The exposure is used to calculate potential dose and ultimately risk.

A potential dose rate (PDR) for the exposed individual was estimated by dividing the annual exposure by an average body weight of 70 kg and 365 days per year as follows:

PDR (mg/kg-day) = Annual exposure (mg/yr) / (70 kg * 365 days/yr)

For the previous example, the annual exposure and PDR were estimated as:

Annual exposure (mg/yr) = 4 lb/yr * (1kg/2.2lb) * 0.043 = 0.078 mg/yr

PDR = (0.078 mg/yr) / (70 kg * 365 days/yr) = $3.1 * 10^{-6}$ mg/kg-day

Calculation of Cancer Risk Estimates and Hazard Quotients

Estimates of the cancer risks and hazard quotients were made for emission sources in the inventory. When available, cancer slope factors for inhalation exposures were used in the calculations. In the absence of cancer slope factors based on inhalation exposures, oral slope factors were used in the risk calculations. For the non-cancer assessments, RfC values were converted to RfDs based on EPA-approved procedures (U.S. EPA, 1997f). Use of an estimated dose and the associated RfD was preferred because the risk assessors needed to evaluate risks for many types of scenarios. RfCs incorporate exposure assumptions and can only be used for one exposure route. As a result, RfCs were converted to RfDs and inhalation doses were calculated for the scenario being assessed (see Region 3 RBC table in Appendix D). In turn, the same estimated doses could be used in the cancer risk calculation by combining it with the cancer slope factor. In a few instances, inhalation cancer slope factors were not available and slope factors based on the oral route were used. In those cases, another uncertainty was introduced to the assessment. It cannot be assumed that oral and inhalation exposures, even at equivalent dosage rates, will result in the same toxicologic response.

Cancer Risk Estimates

These cancer risk calculations were performed using a cancer slope factor and a dose estimated from the inhalation exposure pathway. Another way of calculating cancer risks is to use an approach that uses the unit risk factor and the air concentration. The resulting estimated risks from either approach would be the same as long as the same exposure assumptions are used (e.g., inhalation rate and body weight). Future case studies that implement this methodology will likely use the unit risk factor approach. The unit risk factor (available from IRIS) is expressed in units such as $1/(mg/m^3)$, so multiplication of the unit risk by a given air concentration (in mg/m^3) will yield a cancer risk. This equation assumes the exposure is over a lifetime (70 years). The "lifetime of exposure" includes assumptions of 20 m^3/day inhalation rate, 24 hr/day, 365 days/yr, 70 years exposure duration (equal to a lifetime), and an adult body weight of 70 kg.

An example of the risk calculations for the emissions of cadmium from the SCM facility is shown below:

Cancer risk = Cancer slope factor * Potential dose 6.3 = $(mg/kg\text{-}day)^{-1}$ * 3.1 * 10^{-6} mg/kg-day = 1.95 * 10^{-5}

Hazard quotient = Potential dose/RfD = 3.1 * 10^{-6} mg/kg-day / 5 * 10^{-4} mg/kg-day = 6.2 x 10^{-3}

Source Inventory Database

All toxicity values, exposure estimates, and risk calculations used by the Air Committee in the initial screening were incorporated into the source inventory database. An excerpt from the database for several chemicals is provided below as an illustration of the major database fields that were used in the risk calculations. The example shows how risk and hazard estimates are made for single sources of specific air pollutants using the Turner method.

Pollutant Name	Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Reference Dose (RfD) mg/kg-day	Maximum Total Air Emissions (lbs/yr)	Potential Dose (mg/kg-day) (based on Turner)	Risk (dose*SF) (based on Turner)	Hazard (dose/RfD) (based on Turner)
Acetonitrile		0.0143	4,370	3.34e-03	0.00E+000	2.33e-01
Ammonia		0.0286	290,000	2.21e-01	0.00E+000	7.74e+00
Benzene	0.029	0.00171	7,156*	5.46e-03	1.58E-004	3.19e+00
Carbon tetrachloride	0.0525	0.000571	2,820	2.15e-03	1.13E-004	3.77e+00
Ethylbenzene		0.286	1,772.8	1.35e-03	0.00E+000	4.73e-03
Hydrochloric acid		0.00571	707,808	5.40e-01	0.00E+000	9.46e+01
Toluene		0.114	262.99	2.01e-04	0.00E+000	1.76e-03

Note: This benzene example is from the Baltimore composting facility. Those releases turned out to be inaccurate, as described in the subsequent screening steps (see Table 4).

Selection of Screening Values

Air Committee's Risk Screening Values

- 10^{-6} for Cancer Risk
- Hazard Quotient >1 for Other Chronic Effects

To set screening values, the Air Committee chose a risk level of 1 in 1,000,000 (10^{-6}) for chemicals causing cancer and a hazard quotient greater than 1 (HQ>1) for chemicals with other chronic effects. While this was a consensus decision, there was considerable discussion on the choice of screening values. Because the State of Maryland uses a 10^{-5} risk level for the permitting of facilities that have carcinogenic air emissions, Committee members were concerned that the choice of a more stringent screening value might be

misinterpreted as a critique of the Maryland standards. Despite this concern, the Committee decided that the goals of the Committee justified the use of screening values that differ from the Maryland standards. The Committee decided to stay with the more stringent risk values for several reasons. The Committee designed the screening exercise to identify priority areas for voluntary pollution prevention, not to identify permit violations. The Committee recognized Maryland's concern for misinterpreting of the screening values and decided to make special efforts to clearly communicate the nonregulatory purposes of the screening exercise. The Committee also felt that the 10^{-6} screening value for cancer risk would identify those chemicals that should be considered in the siting of new facilities. Overall, the Committee chose the 10^{-6} screening value as part of its effort to design a screening exercise that would err on the side of extra protection. Using a stringent screening value would help to ensure that any chemicals that might be of concern to the community would be identified and that chemicals not identified for further review would be unlikely to present a significant risk to the community.

Comparison of Cancer Risk Estimates and Hazard Quotients to Screening Values

Cancer risks and hazard quotients were calculated for all chemicals emitted in the Partnership area using the generic Turner method. Ambient air monitoring data were also used in the initial screen to determine if air concentrations might result in risks that exceeded the screening levels. Data from the MDE air monitoring station located in Fairfield, north of the FMC facility, were available for 1992 through 1996. This is the only air monitoring station located in the Partnership neighborhoods that gathers information on air pollutants. This monitoring station takes air samples every day and data are available on the annual average, minimum, and maximum concentrations for 41 toxic chemicals. Of the 41 chemicals monitored, 4 had annual average concentrations in 1996 that resulted in risks that exceeded the Committee screening values (benzene, 1,3-butadiene, carbon tetrachloride, and methyl chloride). The Committee next sorted the cancer risk and hazard quotient columns of the database in descending order to identify the chemicals emitted from the facilities that had cancer risks greater than 10^{-6} and/or a HQ of >1. To satisfy cancer risk and hazard quotient screening criteria, a chemical had to exceed the criteria for at least one facility.

The risk screening criteria were exceeded for 25 chemicals in the inventory. These are listed below:

1.	Formaldehyde	14.	1,3-Butadiene
2.	*Aldrin	15.	Carbon tetrachloride
3.	Methyl chloride	16.	*Ethylene oxide
4.	Benzene	17.	Dioxins & furans
5.	Methylene chloride	18.	Toluene
6.	*Acrylamide	19.	Hydrochloric acid
7.	Cadmium & compounds	20.	Manganese & compounds
8.	*Perchloroethylene	21.	Ammonia
9.	*Trichloromethane	22.	Hydrogen sulfide
10.	*Trichloroethylene	23.	*Chlorine dioxide
11.	Arsenic & compounds	24.	1,2-Dichloropropane
12.	Chromium & compounds	25.	Mercury
13.	Vinyl chloride		

* Chemicals with an "*" were not selected for the next stage of the screening process for reasons such as the chemicals were no longer emitted from the facility because of changes in the production process or the facility was no longer in operation.[7]

A formal attempt to calculate aggregate exposure from multiple sources was not made in the initial screening process. The risk screening values of 10^{-6} for cancer and HQ > 1 for other effects were used to screen only individual sources. Although the Committee did not develop a formal procedure for calculating aggregate exposures in the initial screening, it informally reviewed the risk calculations to see if combining the emissions of individual chemicals from multiple sources could potentially result in additional chemicals exceeding the screening criteria. This review was performed by sorting the database by chemical so that all the risk calculations for each chemical could be viewed at once. If a chemical had no individual facility exceedances of $> 10^{-6}$ for cancer risk or HQ >1 for other effects, but would possibly exceed those criteria when combining the emissions from multiple sources, it would have been selected for further analysis. However, this informal screening for aggregate exposures did not result in any new concerns. (See the lessons learned section for a recommendation regarding the development of a more formal method for screening for aggregate exposures in the initial screening step.)

In addition to the cancer risk and hazard quotient screening criteria, the Committee used other screening criteria to select chemicals for further review. Several chemicals were chosen for inclusion because they had very high emission quantities. These chemicals were as follows:

- Sulfur oxides (SO_x)
- Nitrogen oxides (NO_x)
- Carbon monoxide (CO)
- Carbonyl sulfide
- Xylenes

[7] A lesson learned for this stage of the screening was the need to keep detailed records of the decisions made and the reasons for the decisions. This will make it easier to present a more complete summary of the initial screening step.

Total emission rates in the Partnership area for sulfur oxides, nitrogen oxides, carbon monoxide, and carbonyl sulfide were greater than 1 million lb/yr each. Because the total emission rate for xylenes was relatively high (> 400,000 lb/yr), it was also selected.

The Committee also used professional judgment to select additional chemicals for review. This was especially important for those chemicals for which there was no toxicity information available at the time of the screening exercise.[8] Committee members used their diverse backgrounds and experience in the fields of exposure assessment, toxicology, risk assessment, and regulation of air emissions to make these judgments. The following chemicals were included using these more subjective criteria:

- Hydrogen fluoride
- Lead
- Nickel
- Stoddard solvent
- Sulfuric acid
- Molybdenum trioxide

The results of the initial screen, including the chemicals of concern and their basis for selection, are provided in Table 2. With the inventory of chemicals now reduced, the Committee proceeded to look more carefully at the remaining 29 chemicals. Details of the analysis for the 29 chemicals in the next step of the process (the secondary screen) are provided in the following chapter.

[8] Toxicity data are not available for all chemicals and for all health effects. Such data may not be available because the chemicals have not been tested and because consensus has not been reached on the toxicity value. This risk screening exercise was performed in 1997 based on available data at the time. The toxicity data contained in IRIS and HEAST are regularly updated. However, additional chemicals would not have been identified from the initial screen even if more current toxicity data were used.

Table 2. Chemicals Selected from Initial Screen

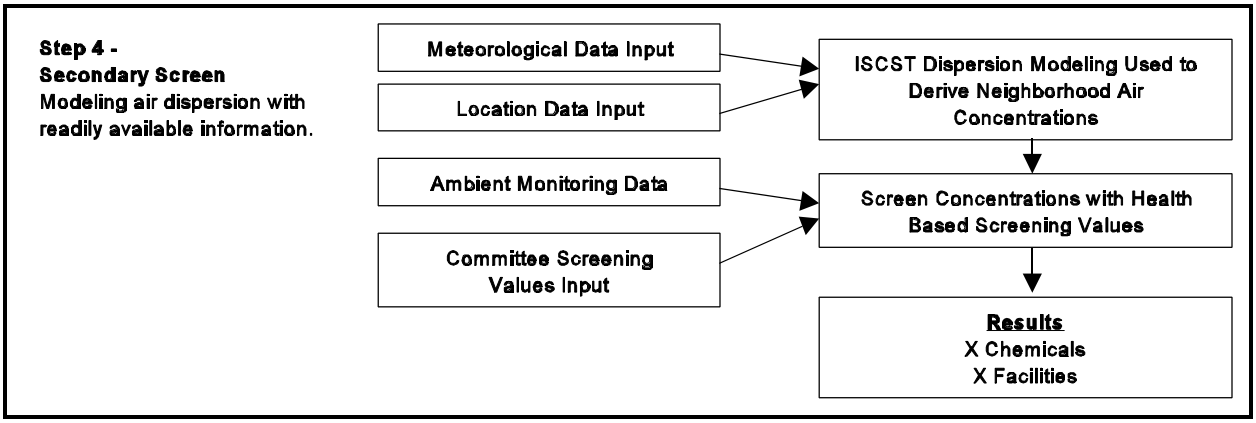
Chemical Name	CAS Number	No. of Facilities	Basis for Selection[a]
Ammonia	7664-41-7	14	HQ > 1
Arsenic	7440-38-2	5	Cancer risk estimate > 10^{-6}
Benzene	71-43-2	23	Cancer risk estimate >10^{-6}/Monitoring data
1,3-Butadiene	106-99-0	1	Cancer risk estimate > 10^{-6}/Monitoring data
Cadmium	7440-43-9	3	Cancer risk estimate > 10^{-6}
Carbon monoxide	630-08-0	51	Over 1,000,000 in total emissions
Carbon tetrachloride	56-23-5	4	Cancer risk estimate > 10^{-6} and HQ > 1 /Monitoring data
Carbonyl sulfide	463-58-1	1	Over 1,000,000 in total emissions
Chromium compounds (III, VI)	7440-47-3	10	Cancer risk estimate > 10^{-6} and HQ > 1
1,2-Dichloropropane	78-87-5	1	Cancer risk estimate > 10^{-6}
Dioxin (2,3,7,8-TCDD)	1746-01-6	3	Cancer risk estimate > 10^{-6}
Formaldehyde	50-00-0	5	Cancer risk estimate > 10^{-6}
Hydrochloric acid	7647-01-0	20	HQ > 1
Hydrogen fluoride	7664-39-3	1	General criteria: Toxicity concerns + emission sources
Hydrogen sulfide	7783-06-4	4	HQ > 1
Lead	15347-57-6	3	General criteria: Toxicity concerns + emission sources
Manganese	7439-96-5	7	HQ > 1
Mercury	7439-97-6	2	HQ > 1
Methyl chloride	74-87-3	2	Cancer risk estimate > 10^{-6}/Monitoring data
Methylene chloride	75-09-2	7	Cancer risk estimate > 10^{-6}
Molybdenum trioxide	1313-27-5	1	General criteria: Toxicity concerns + emission sources
Nickel	7440-02-0	7	General criteria: Toxicity concerns + emission sources
Nitrogen oxides	11104-93-1	79	Emissions > 1,000,000 lb/yr

Table 2. Chemicals Selected from Initial Screen (Continued)

Chemical Name	CAS Number	No. of Facilities	Basis for Selection[a]
Stoddard solvent	8052-41-3	2	General criteria: Toxicity concerns + emission sources
Sulfur oxides	SEQ:111[b]	48	Emissions > 1,000,000
Sulfuric acid	7664-93-9	13	General criteria: Toxicity concerns + emission sources
Toluene	109-88-3	40	HQ > 1
Vinyl chloride	75-01-4	2	Cancer risk estimates > 10^{-6}
Xylene	1330-20-7	49	Emissions (49 facilities with total emissions of 433,000 lb/yr)

a. All chemicals, except four, were selected on the basis of modeling air concentrations from emissions. The four chemicals selected based on ambient air monitoring data were benzene, 1,3-butadiene, carbon tetrachloride, and methyl chloride.
b. Chemical not registered by the Chemical Abstract Service. Sequence (SEQ) numbers are assigned arbitrarily.

SECONDARY SCREEN (STEP 4)



Overview

The 29 chemicals identified in the initial screen were the starting point for the secondary screen. Instead of using the Turner method to estimate concentrations, computer air dispersion modeling was used in this step to estimate aggregate concentrations from the facility sources. This air dispersion modeling provided a more realistic estimate of exposures than the very protective calculations used in the initial screen and was consistent with the kind of tiered modeling approach recommended in "A Tiered Modeling Approach for Assessing the Risks Due to Sources of Hazardous Air Pollutants" (U.S. EPA, 1992b). New information required for the secondary screening included facility location information and local meteorological data. The Air Committee also chose new screening values, described below, for this and the final step of the screening exercise. Chemicals that were identified in the initial screen based on monitored concentrations were also kept on the list of chemicals for further review in the secondary screen.

Secondary Screen

- 29 Chemicals Identified from the Initial Screen Used as the Starting Point
- Air Dispersion Model Used To Estimate Ambient Air Concentrations
- New Committee Screening Values set at 50 percent of Risk-Based Concentrations (RBCs) Developed by EPA Region 3
- Secondary Screen Identified 7 Chemicals of Concern from 23 Facilities

Modeling efforts for the 29 chemicals were performed by the EPA technical staff using the Industrial Source Complex Short-term Version 3 (ISCST3) model to estimate ambient concentrations (U.S. EPA, 1995). This model takes into account emissions from point and area sources and estimates the dispersion of chemicals in the ambient air by using local meteorology

data. The output from ISCST3 are estimates of hourly, monthly, and/or annual concentrations at receptor locations. The time required for modeling depends on the number of sources and the chemicals selected for modeling. The modeling for this project took several weeks to complete. General modeling efforts included:

- Building a modeling input file using data from the source emissions inventory database,
- Developing a grid system for the model,
- Locating facilities and neighborhoods in the modeling grid, and
- Running the model.

Appendix K provides background information on model setup, assumptions, and a chronology of modeling runs with ISCST3. Modeling scenario 1 in Appendix K is the modeling for the secondary screen. Scenario 2 represents an intermediate step that included more accurate information on emissions. Scenario 3 incorporated additional information on the type of chromium (Cr^{+3} or Cr^{+6}) emitted by facilities, and added updated data on benzene emissions. Scenario 4 was used to determine the contribution of individual facilities' benzene emissions to the total modeled benzene concentration in Wagners Point.

Once the input was completed, estimates were generated of the chemical concentrations in each neighborhood from all known releases of a chemical, along with estimates of the highest concentrations modeled anywhere within the grid system. The estimated air concentrations were compared to the screening values chosen by the Committee. Monitored concentrations were also compared to the new screening values. For the secondary screening step, the Committee decided to switch and use the Region 3 risk-based concentrations (RBCs) as the basis for its screening values. The Region 3 RBCs were calculated to correspond to a 1 in 1,000,000 (10^{-6}) cancer risk and/or an HQ of 1. The Committee decided to use 50% of the Region 3 RBCs as its screening value. These were more protective values than the ones used in the initial screen.

At this point in the process, the Committee also decided to group chemicals that have similar effects (e.g., neurological effects and respiratory tract irritants) to look at the possibility of cumulative effects that might result from exposure to combinations of different chemicals. Details of this cumulative screening are discussed below.

Results of the secondary screen showed that concentrations for 7 of the 29 chemicals were above the Committee screening values in one or more

Secondary Screen Results

- 7 Chemicals Above Committee Screening Values

- Modeled Chemicals
  - Benzene
  - Chromium
  - Hydrochloric Acid
  - Manganese

- Monitored Chemicals
  - Benzene
  - 1,3-Butadiene
  - Carbon Tetrachloride
  - Methyl Chloride

Partnership neighborhoods. Four chemicals were identified by modeling, four chemicals were identified by monitoring, and one chemical was selected by both. The Air Committee decided to carry these seven chemicals to the final screen. The Committee did not communicate the results of this step to the community at large. Although the Committee did not reach a consensus on the communication of these results to the community, the Committee held several discussions on the interpretation of the screening results. Several draft reports from this screening exercise were prepared, but they were not approved for release to the community by the Committee. Communication with the facilities that were not already members of the Partnership, but were releasing chemicals with estimated concentrations at or above the screening values, was initiated to encourage participation.

In addition to air modeling, the Air Committee focused on providing Committee members with background information to ensure that each member understood the steps in the process and could fully participate in the discussions and decisions. Therefore, the Committee organized a special meeting devoted to explaining and discussing the basic science of the screening exercise, as well as toxicology, exposure, risk, and modeling. Residents communicated their concerns about facility emissions and explored whether air dispersion modeling could provide answers to their questions. The Air Committee attempted to answer all the questions from the members (and the Committee) to ensure confidence in the overall screening process.

Completing the Secondary Screen

The 29 chemicals selected from the initial screen were carried through the secondary screen to determine if they were chemicals of concern.

Air Dispersion Modeling

Air dispersion modeling was conducted using Version 3 (ISCST3) model. ISCST3 has been tested, validated, and widely used by EPA and State government organizations for risk assessment, regulatory, and permitting purposes. This model was selected for a variety of reasons, including its ability to be tailored for local conditions and to model chemical emissions from multiple sources (U.S. EPA, 1987). ISCST3 was used to estimate the ambient concentrations of chemicals emitted from the wide variety of air pollution sources associated with industrial activities in and around the Partnership area. The results of the modeling were used to determine which air pollution stationary sources needed further characterization and which could be screened out as not likely to

Air Dispersion Modeling for Step 4

- ISCST3 Model Used
- Emissions from Point and Area Sources Considered
- Model Estimated Annual Average Concentrations at Receptor Locations
- Receptor Sites Included:
  - Brooklyn/Brooklyn Park
  - Cherry Hill
  - Wagners Point
  - Curtis Bay

have a significant impact on human health. For chemicals that were emitted by too many facilities to feasibly model, enough facilities were chosen so that at least 95 percent of the total mass emitted was captured. Professional judgment was used to verify that omitted facilities would not affect the analysis (e.g., low quantities were emitted or facilities were not located near populated areas).

Model Description

ISCST3 was designed to calculate ground-level average concentrations and/or total deposition values emitted from single or multiple stationary sources (U.S. EPA, 1995). ISCST3 uses meteorological data and site-specific parameters (e.g., stack parameters and pollutant emission rates) to calculate hourly, monthly, and/or annual average concentrations, as well as deposition values. The calculations can be performed at each receptor (neighborhood) on a coordinate grid for each source or for combined emissions from select groups or all sources.

For the purpose of ISCST3 modeling, stationary sources in the Partnership area were divided into point and area sources,[9] based on the characteristics of their emissions. Point sources are generally associated with a specific point defined by the location on the emissions/receptor coordinate grid. In the modeling exercise, point sources are generally exhaust stacks with a defined height, diameter, and other associated variables. The emission rates entered into the model for these types of sources were in units of mass per unit time (e.g., lb/hr). Area sources in the context of ISCST3 modeling are emissions that do not originate from a specific point, such as a stack, but are emitted from an area of known width and length (e.g., evaporation from a wastewater treatment plant or leaks from a fuel terminal). The emissions rates entered into the model for these types of sources were in units of mass per area per unit time (e.g., pounds per square foot per hour [$lb/ft^2/hr$]). The use of the term "area source" in this context should not be confused with that of "area source" under the Clean Air Act (i.e., a stationary source of hazardous air pollutants that is not a "major" source).

Model Setup and Assumptions Used

ISCST3 requires emissions data, meteorological data, and facility information as modeling input. The emissions of each chemical and stack parameters for each facility studied were identified from information provided by MDE. (Example shown in Appendix F.) In most cases, maximum permitted emissions of each chemical for each facility were used as the emissions input for the secondary screen. The characterization of each emission as stack or fugitive was made based on professional judgment by an engineer familiar with most of the facilities. Both toxic and criteria air pollutants were modeled using local meteorological data from the most current years

[9] The terms point sources and area sources, when used in the context of dispersion modeling, are different than when used for defining types of sources based on the Clean Air Act (point, area, mobile sources). See footnote number 2 for further discussion.

available (1987-1988, 1990-1992). Generally, meteorological data over a 5-year span are used in air dispersion modeling to account for temporal variations.

Data to characterize area sources were not available as part of the secondary screen. Default assumptions based on the best engineering judgment were used as follows: small area sources (such as gas stations) were assumed to be 50 x 50 meters and 3 meters emissions height. Large area sources (such as large industrial facilities) were assumed to be 500 x 500 meters and 30 meters emissions height.

Receptor Grid and Model Outputs

ISCST3 was run using a Cartesian coordinate source and two receptor grids. The coarse grid with 2,000 m spacing was 18,000 16,000 m, or about 110 square miles (Figure 3). This coarse grid allowed for prediction of air concentrations for 72 receptor locations in a 110-square-mile area around the Partnership neighborhoods. The coarse grid was used in order to reduce the number of computations when including facilities up to 5 miles away from the Partnership area. Since no calculations outside of the Partnership neighborhoods were needed for the distant emissions sources, but the coarse grid could still provide estimates within the Partnership neighborhoods for these pollutants, use of the coarse grid was preferred over the much more computationally demanding fine grid covering the same area. The fine grid, with 250 m grid spacing, was 5,000 meters on a side, or about 10 square miles. This fine grid provided better resolution of the air concentrations (at 700 receptor locations) in the Partnership neighborhoods (Figure 4).

Selection of Facilities Modeled

For the priority chemicals with multiple emission sources, a subset of 36 sources was selected to reduce the number of facilities for air modeling. The focus was placed on those facilities whose emissions accounted for at least 95 percent of the mass of total emissions. For example, manganese was emitted by seven facilities, but only two facilities were modeled (Chemetals and Bethlehem Steel) because they accounted for more than 95 percent of the total mass of manganese emitted in the Partnership area. An additional selection criterion was used in the case of benzene to cover the range of sources so that some small sources such as gas stations were included along with the larger sources of emissions. The facilities selected for air modeling for this stage of the analysis are listed in Appendix H.

Selection of Receptor Sites

ISCST3 was used to estimate ambient air pollutant concentrations for the 4 Partnership neighborhoods, Cherry Hill, Brooklyn/Brooklyn Park, Curtis Bay, and Wagners Point. The coordinates used for modeling corresponded with the approximate geographic centers of these four communities. Recognizing that air pollutants may be transported from outside the Partnership area, facilities within 5 miles of the Partnership area were included in the emissions

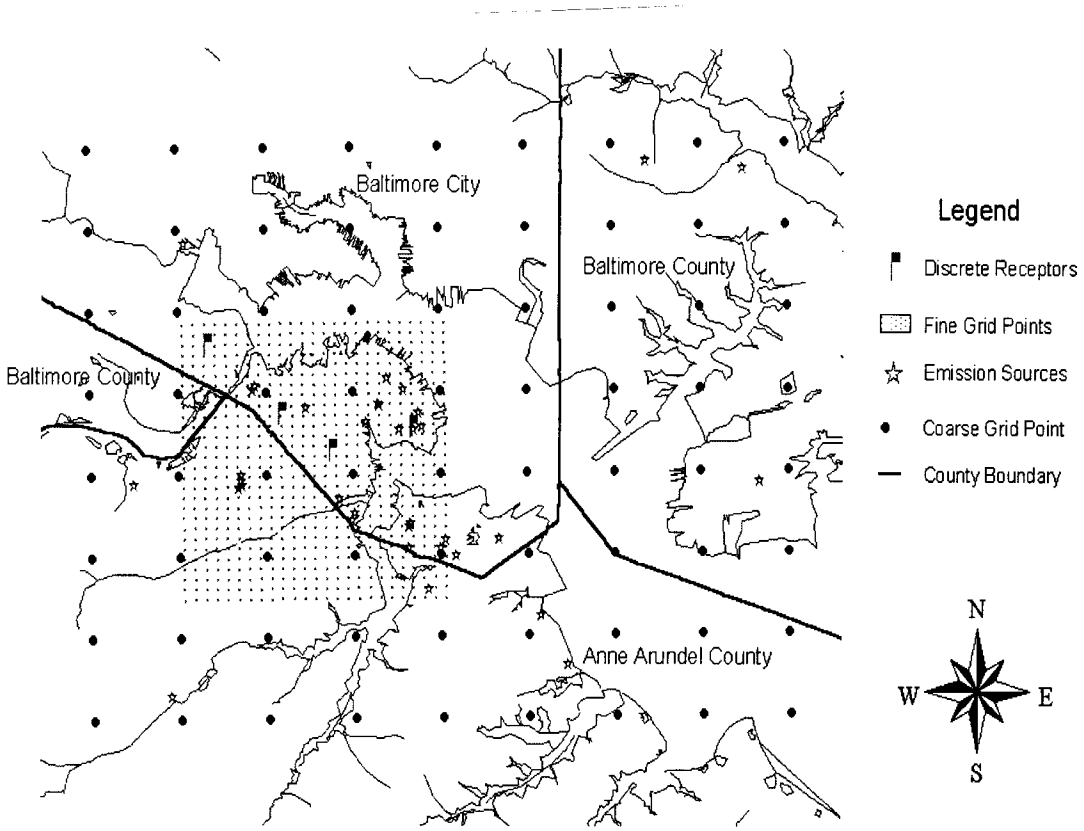


Figure 3. Coarse Receptor Grid in Baltimore

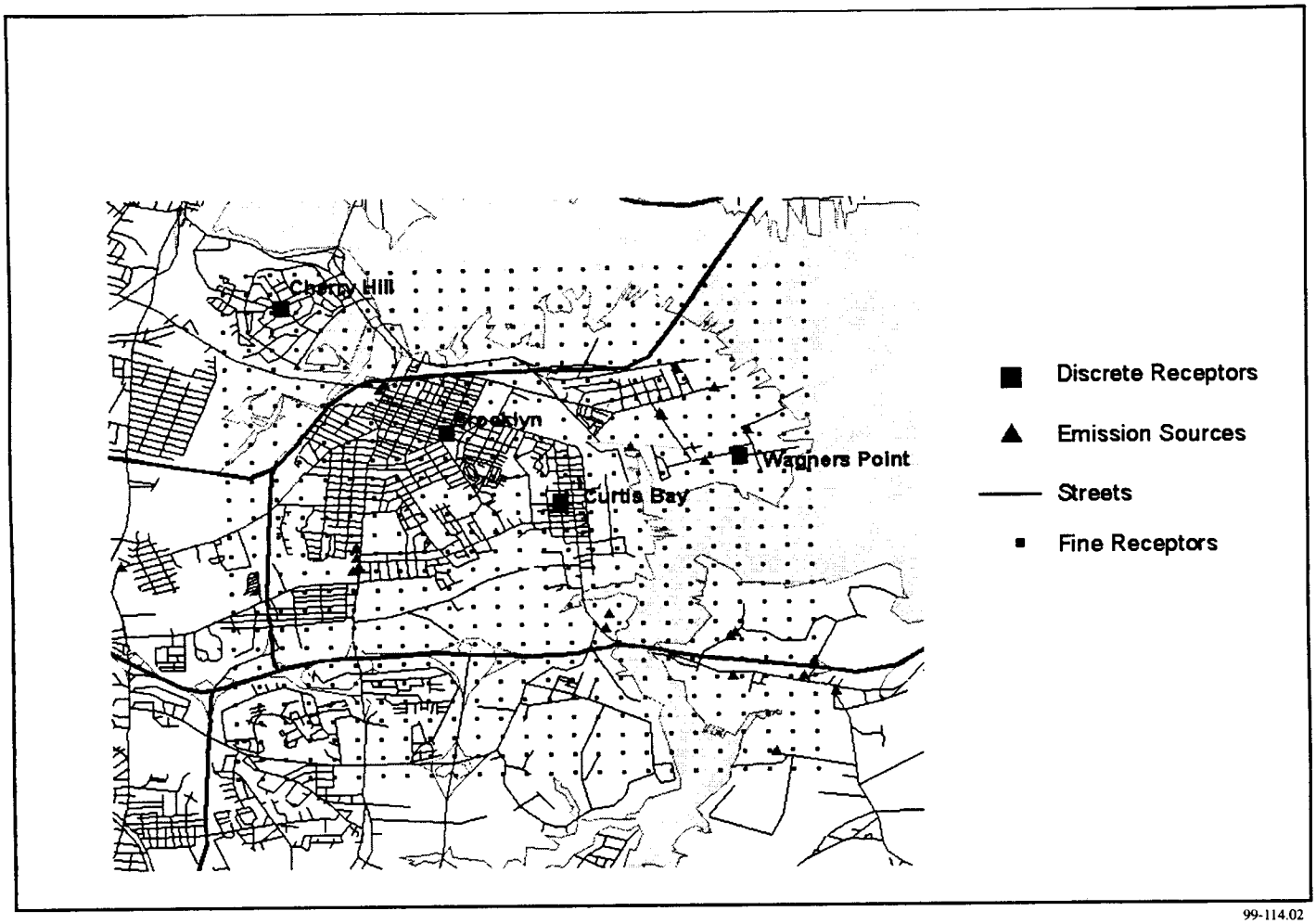


Figure 4. Fine Receptor Grid in Baltimore

inventory. While this approach did not capture pollution transported from other regions of the United States, it represents an exhaustive attempt to consider local commercial and industrial stationary sources (Figure 4).

Selection of Health-Based Screening Levels and Endpoints

For this stage of the screening process, the Committee used 50 percent of the RBCs calculated by Region 3 as the screening values. The RBCs provided a concentration benchmark to compare directly to the concentrations estimated by the modeling or measured at the monitoring stations. The RBCs (U.S. EPA, 1997d) are the concentrations at which either the cancer risk to an exposed population is 1 in 1,000,000 or the HQ is 1. If the monitored or modeled concentrations exceeded 50 percent of the RBCs, then the chemical was identified as a candidate for further analysis. The assumptions built into the RBCs are provided in Appendix D. A review and potential adjustment of these assumptions was identified for future improvement of the screening methodology to ensure the protection of sensitive populations.

Grouping of Chemicals with Similar Target Organs or Physiological Systems

The Air Committee reviewed the toxicology information for the 29 chemicals to screen for possible cumulative effects from exposure to multiple chemicals and to identify chemicals with similar target organs or physiological systems. On the basis of this review, chemicals with known neurological effects and chemicals that act as respiratory tract irritants were grouped together. Cumulative exposures resulting from the chemical groupings did not result in any new concerns. The chemicals reviewed and results of the cumulative assessment can be seen in Table I-2 in Appendix I.

Chemicals with Monitoring Data

Data from a monitoring station located within the Partnership area were available for 4 of the 29 chemicals: benzene, 1,3-butadiene, carbon tetrachloride, and methyl chloride. (See Appendix F for an example of air toxics monitoring data.) These data were compared with the screening concentrations to determine if the monitored levels were greater than the modeled levels and/or the screening levels. All four chemicals were found at levels above the RBCs, so additional study of on these chemicals was warranted as part of the final screen. For 1,3-butadiene, evaluation was based only on monitoring data because there were no significant stationary emission sources in the Partnership area to model.

Results of Secondary Screening

The 29 chemicals selected in the initial screening step, including 18 by risk screening, 5 by emission quantity, and 6 by professional judgment, were carried through the secondary screen for further analysis. Monitoring data for any of these chemicals, if available, were examined to determine whether monitored data or modeled data had higher concentrations. The data with higher concentrations were compared against the risk screening values before performing the next step. The estimated concentrations and monitored concentrations, as well as the corresponding percentage of the screening value for each concentration, were presented in table format for Committee review. This table is presented in Appendix I. A second table, indicating only whether or not more information was needed, was also developed for Committee review. (See Table 3.) Those chemicals having concentrations above the committee screening level were identified as needing further analysis in the final screen step.

Chemicals Not Requiring Further Evaluation

For 22 of the 29 pollutants, estimated concentrations from modeling or measured concentrations from monitoring were well below the Air Committee's screening criteria in all the neighborhoods. Because of the low concentrations, the Air Committee concluded that no further evaluation was needed for the 22 chemicals.

Secondary Screening Chemicals

Seven of 29 Pollutants Exceeded 50 Percent of Screening Value in One or More Neighborhoods.

- Benzene from *monitored* and *modeled* concentrations
- 1,3-Butadiene from *monitored* concentrations
- Carbon Tetrachloride from *monitored* concentrations
- Chromium from *modeled* concentrations
- Hydrochloric Acid from *modeled* concentrations
- Manganese from *modeled* concentrations
- Methyl Chloride from *monitored* concentrations

Chemicals Recommended for Further Evaluation

Concentrations for 7 of the 29 pollutants exceeded 50 percent of their respective screening values in one or more of the neighborhoods. Benzene, 1,3-butadiene, carbon tetrachloride, and methyl chloride were identified based on the monitored concentrations. Benzene, chromium, hydrochloric acid, and manganese were identified by the modeled concentrations. (Benzene had both monitored and modeled concentrations greater than 50 percent of its RBC.) The Air Committee recommended further evaluation for each of these seven chemicals as part of the final screening step.

Interpretation and Communication of Results

The results of the screening exercise were presented to the Committee in different table formats, and the advantages of each format were discussed. Draft reports interpreting these results were also discussed in the Committee. At this point, the Committee did not reach a consensus on a format for the presentation of the information to the community.

Table 3. Results of Secondary Screening for Target Toxics in Partnership Neighborhoods

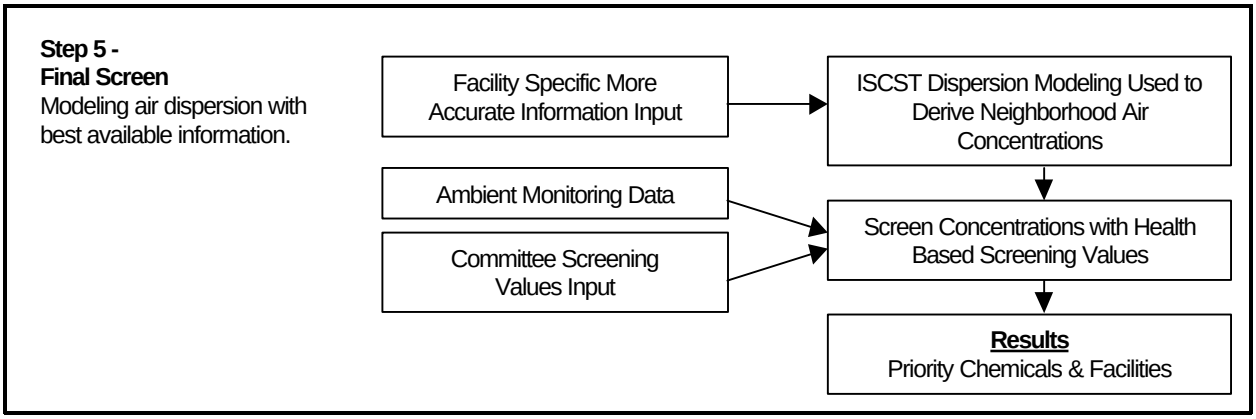
Chemical	Neighborhood Concentrations (from modeling)				State-Operated Monitoring Station Results
	Cherry Hill	Brooklyn/ Brooklyn Park	Curtis Bay	Wagners Point	
Ammonia	Low[a]	Low	Low	Low	
Arsenic*	Low	Low	Low	Low	
Benzene*[b]	Low	Low	Low	**Needs more information[c]**	**Needs more information**
1,3-Butadiene*[d]	--	--	--	--	**Needs more information**
Cadmium*	Low	Low	Low	Low	
Carbon monoxide	Low	Low	Low	Low	
Carbon tetrachloride*	Low	Low	Low	Low	**Needs more information**
Carbonyl sulfide	Low	Low	Low	Low	
Chromium (Hexavalent)*	**Needs more information**	**Needs more information**	**Needs more information**	**Needs more information**	
Chromium (Trivalent)	Low	Low	Low	**Needs more information**	
1,2-Dichloropropane*[e]	Low	Low	Low	Low	
Dioxin* (2,3,7,8 TCDD)	Low	Low	Low	Low	
Formaldehyde*	Low	Low	Low	Low	
Hydrochloric acid	Low	Low	**Needs more information**	**Needs more information**	

Table 3. Results of Secondary Screening for Target Toxics in Partnership Neighborhoods (continued)

Chemical	Neighborhood Concentrations (from modeling)				State-Operated Monitoring Station Results
	Cherry Hill	Brooklyn/ Brooklyn Park	Curtis Bay	Wagners Point	
Hydrogen fluoride	Low	Low	Low	Low	
Hydrogen sulfide	Low	Low	Low	Low	
Lead	Low	Low	Low	Low	
Manganese	Low	Low	**Needs more information**	**Needs more information**	
Mercury	Low	Low	Low	Low	
Methyl chloride*	Low	Low	Low	Low	**Needs more information**
Methylene chloride*	Low	Low	Low	Low	
Molybdenum trioxide	Low	Low	Low	Low	
Nickel	Low	Low	Low	Low	
Nitrogen oxides	Low	Low	Low	Low	
Stoddard Solvent	Low	Low	Low	Low	
Sulfur oxides	Low	Low	Low	Low	
Sulfuric acid	Low	Low	Low	Low	
Toluene	Low	Low	Low	Low	
Vinyl chloride*	Low	Low	Low	Low	
Xylene	Low	Low	Low	Low	

a. Low concentrations from modeling; no further work was needed.
b. (*) refers to carcinogens.
c. Areas marked as "Needs more information" had modeled concentrations above 50 percent of the risk-based concentration (RBC) chosen by the Partnership Air Committee. These chemicals were candidates for further screening.
d. Modeling was not conducted because facility emissions were not available.
e. 1,2-Dichloropropane is a carcinogen via the oral route.

FINAL SCREEN (STEP 5)



Overview

The final screening step used the most accurate information available to better characterize annual emissions. This refined information was used to identify the chemicals and facilities of most concern to the Partnership neighborhoods. The final screen began with the seven chemicals identified in the previous step. The seven chemicals were emitted from 23 facilities and/or measured at the local monitoring station. The final screen identified four of the seven chemicals as community priorities.

Final Screen

- Started with 7 Chemicals from 23 Facilities
- Used Refined Source Emission Data for More Accurate Modeling
- Used Ambient Air Monitoring Data for Certain Chemicals
- Result of Final Screen: 4 Chemicals (Benzene, 1,3-Butadiene, Carbon Tetrachloride, and Methyl Chloride)

To collect the most accurate information, members of the Partnership Air Committee contacted representatives of the 23 facilities or consulted MDE files to obtain annual emissions measurements or estimates from the emissions compliance statements submitted to the State each year by permitted facilities. When this information was not available, TRI emissions to air for the most recent year (1996) were used. In addition, improved data were solicited on stack heights, facility location, dimensions, and so forth, which resulted in a more accurate estimate of neighborhood concentrations by the ISCST3 modeling. Additional information on the type of chromium emitted to the air was also collected. Based on the new information, neighborhood concentrations were re-estimated and compared to the Air Committee screening values. Any chemicals with monitored or modeled concentrations above the screening values were identified as priority chemicals for the community. Step 6, which follows, describes how the Committee

developed recommendations for addressing the priority chemicals and began work to communicate the recommendations and results of the screening to the community.

Completing the Final Screen

Collection of Toxicity Information

Information on the toxicity of the remaining chemicals was found in the EPA Region 3 RBC table (U.S. EPA, 1997d). The risk screening was conducted as in the secondary screen. The only new information needed at this step was toxicity information on the type of chromium (trivalent or hexavalent) emitted from facilities in the Partnership area. Earlier screening steps used a conservative assumption that all chromium emitted from the facilities to air was the more toxic hexavalent chromium. The final screening was based on a more accurate estimate of the form of chromium in the emissions.

Air Modeling

Four of the seven chemicals selected for the final screen (benzene, chromium, hydrochloric acid, and manganese) had local facility sources. Air dispersion modeling was conducted for these chemicals using the ISCST3 model, as in the previous step. Modeling results were used to determine which facility sources should be candidates for voluntary pollution prevention and emissions reductions.

Modeling Inputs and Assumptions

For the final screen modeling, emission rates, selection of facilities, and stack parameters were refined with more accurate data. All other modeling inputs and assumptions remained the same as in Step 4. Instead of using maximum state-permitted emissions, yearly air emissions were obtained from the annual emissions compliance statements filed with MDE. This emission information was derived from stack monitoring or engineering estimates and is based on the expected performance of the facility. A comparison of the emission rates for the secondary and final screens for the four modeled chemicals can be found in Table 4.

Selection of Facilities Modeled

Twenty-three facilities with emissions of the four targeted chemicals were selected for air dispersion modeling in the final screen. The facilities, chemicals emitted, and emissions amounts are listed in Table 4.

Table 4. Emission Rates from Facilities Used in Secondary and Final Screens [a]

Facility Name	Pollutant Name	Secondary Screen Emission Rate (lb/yr)	Final Screen Emission Rate (lb/yr)
Amerada Hess	Benzene	NA	652
Amoco Oil Co.	Benzene	4,000	80
Amoco Station	Benzene	NA	66
Amoco Station	Benzene	NA	67
Baltimore Composting	Benzene	7,156	7,156[b]
Baltimore Resco	Chromium	3,333	67 (+3); 3 (+6)
	Hydrochloric acid	6,126,000	6,126,000
Bethlehem Steel	Chromium	848	848 (+3)
	Manganese	20,124	20,124
BGE Brandon Shores[c]	Chromium	909	633 (+3); 276 (+6)
	Hydrochloric acid	4,200,000	4,200,000
BGE Wagner Station[c]	Chromium	294	204 (+3); 90 (+6)
	Hydrochloric Acid	1,300,000	1,300,000
Bayway Terminal	Benzene	1,120	220
Chemetals Corp.	Hydrochloric acid	23,172	8,758
	Manganese	61,661	16,300
Citgo Station	Benzene	122	61
CONDEA-Vista Chem.	Benzene	3,000	2,200
	Hydrochloric acid	21,000	12,000
Crown Station	Benzene	NA	62
Crown Station	Benzene	NA	44
Grace Davison	Chromium	122	122 (+3)
Med Net/MedX Inc.	Hydrochloric acid	42,300	6,520
MOTIVA (Mobil Oil-Maritank)	Benzene	882	1,440
Norris Farm Landfill	Benzene	1,051	16
Phoenix Services	Hydrochloric acid	91,016	6,952
MOTIVA (Shell Oil Terminal)	Benzene	1,400	480
Shell Station	Benzene	130	65
CITCO (Star Enterprises)	Benzene	NA	348
Stratus Petroleum	Benzene	NA	880
U.S. Gypsum	Chromium	26	26 (+3)

NA Not available (several benzene sources were discussed as part of the final screen; no data were included in the secondary screen).

a. Emissions data for 1,3-butadiene, carbon tetrachloride, and methyl chloride were not included in this table, since assessment of risk was based on monitoring data and not emissions from stationary source.

b. This number was determined to be erroneous; however, the emissions did not affect the Partnership neighborhoods.

c. Estimates were based on design and operating parameters.

Results of the Final Screen

Of the four chemicals modeled in the final screen, only benzene emissions were estimated to result in airborne concentrations in a Partnership neighborhood at levels above the Committee screening level. Table 5 displays estimated air concentrations of chemicals from the secondary and final screens.

To help identify the contribution of each of the facility sources of benzene to the modeled concentrations in the Wagners Point neighborhood, model runs were conducted in a manner such that each benzene source was considered individually. The ISCST3 model was run repeatedly with only one benzene source "turned on" at a time. This yielded an estimated maximum airborne concentration due to the single emissions source under consideration. That value was compared to the estimated concentration due to all sources to determine the contribution of that source (percentage of the total). Petrochemical storage facilities in the Wagners Point area were identified as the primary source of the modeled benzene concentrations.

In addition to determining the contribution of each source to the modeled concentration, the Air Committee examined monitoring data for benzene in the Partnership area and a comparison of the two values was performed to determine how closely the modeled concentration matched the monitored concentration. The monitoring station in Fairfield is about ½ mile from the location of the highest predicted concentration of benzene in Wagners Point. At this distance the two locations could be unequally subject to influences, such as nearby benzene sources or differences in wind direction and frequency, that could confound the comparison of benzene concentrations. Nonetheless, if it is assumed that the modeling is accurate, then significant differences between measured benzene concentrations and modeled benzene concentrations could be due to sources of benzene not captured in the emissions inventory.

The results of this effort were used to develop the pie chart in Figure 5. The pie chart shows the estimated individual contribution of each facility to the ambient benzene concentrations measured at the monitoring station located approximately ½ mile from the Wagners Point neighborhood (Fairfield). This pie chart allows for a comparison of the modeled facility contributions (12 percent) to other nonmodeled sources (88 percent). It is well known that mobile sources make a significant contribution of benzene to urban air (U.S. EPA, 1999e). (Mobile sources were not modeled by the Air Committee, but their inclusion in future efforts is highly recommended.) On the basis of this information, the Air Committee concluded that a significant portion of the unaccounted for benzene concentration monitored at the Fairfield station could be attributed to mobile sources, likely benzene emitted from mobile sources (cars and trucks) passing through the area on high-volume routes such as I- 695 and Patapsco Ave and at the I-895 toll plaza. A more precise determination of the sources of the measured benzene could not be made because the Committee was unable to completely determine if all nonmobile sources had been accounted for. There may be additional unregistered local sources or other local sources not included in the modeling. There may also be some transport of benzene into the Partnership area from beyond the

Table 5. Estimated Air Concentrations of Chemicals from Secondary and Final Screens

	Concentration Averaging Time	Benzene ($\mu g/m^3$)		Chromium & Compounds Total ($\mu g/m^3$)		Chromium (+3) ($\mu g/m^3$)		Chromium (+6) ($\mu g/m^3$)		Hydrochloric Acid ($\mu g/m^3$)		Manganese ($\mu g/m^3$)	
Receptor		**Secondary**	**Final**	**Secondary**	**Final**	**Secondary**	**Final**	**Secondary**	**Final**	**Secondary**	**Final**	**Secondary**	**Final**
Cherry Hill	Annual	0.003	0.0028	0.0001	NA	NA	0.00008	NA	0.00001	1.5	1.4	0.014	0.0044
Wagners Point	Annual	0.19	0.41	0.0006	NA	NA	0.00026	NA	0.00001	8.4	0.89	0.054	0.016
Brooklyn	Annual	0.008	0.0078	0.0004	NA	NA	0.00011	NA	0.00001	1.5	0.74	0.024	0.0072
Curtis Bay	Annual	0.019	0.014	0.0004	NA	NA	0.00017	NA	0.00001	3.7	0.66	0.039	0.011

$\mu g/m^3$ = micrograms per cubic meter
NA = Not Applicable.

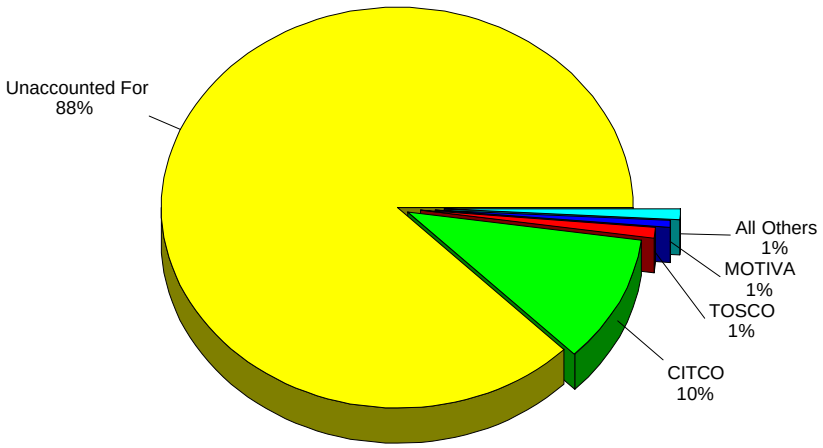


Figure 5. Comparison of Unknown to Stationary Sources of Benzene Between the FMC Monitoring Station and Modeled Concentrations

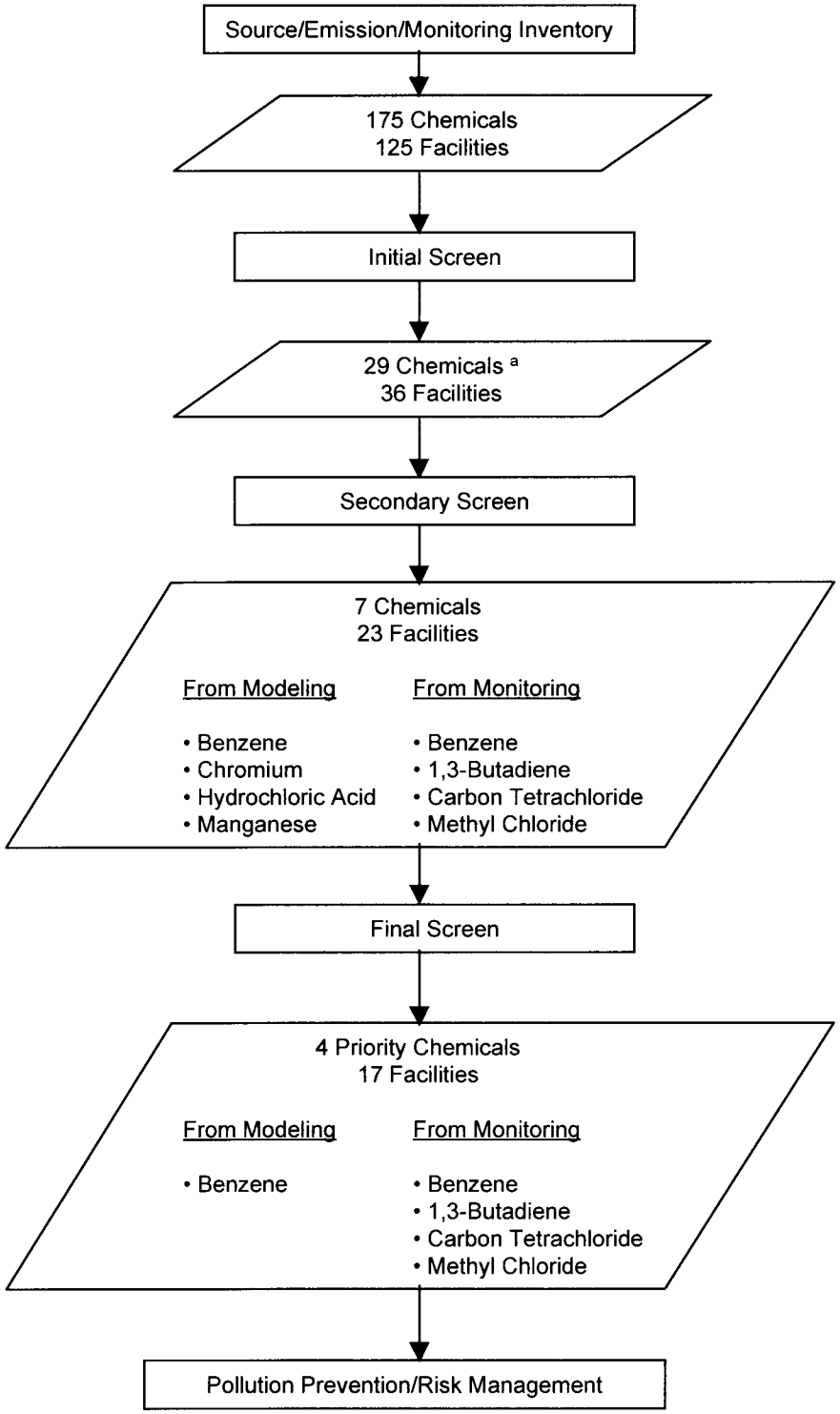
15-square-mile area considered in the study. It is also possible that the model may have underestimated the contribution of the modeled facility sources.

Ambient air monitoring data from the monitoring station in Fairfield indicated the presence of four chemicals (i.e., benzene, 1,3-butadiene, carbon tetrachloride, and methyl chloride) with annual average concentrations greater than the Committee screening levels. With the exception of benzene, no significant sources of these chemicals were listed in the emissions inventory. Benzene is emitted from both stationary and mobile sources; 1,3-butadiene most likely originates from mobile sources; carbon tetrachloride and methyl chloride are typically present in urban air at levels monitored in the Partnership area. (See description in the Air Committee Report in Appendix J.)

The results from each screening step are shown in Figure 6. Initially, the inventory consisted of 175 chemicals. As a result of the screening process, four chemicals of concern were identified, three from monitoring data alone and one (benzene) from both modeling and monitoring data.

Chemicals Identified in Final Screen

Monitoring	Modeling
• Benzene	• Benzene
• Methyl Chloride	
• 1,3-Butadiene	
• Carbon Tetrachloride	



[a] 18 chemicals were selected by risk screening;
5 chemicals were selected by emission quantity; and
6 based on professional judgement.

Figure 6. Baltimore Air Screening Results

DEVELOPED RECOMMENDATIONS AND COMMUNICATED RESULTS TO THE BROADER COMMUNITY (STEP 6)

Step 6 - Recommendations and Communication

Develop Pollution Prevention and Risk Management Recommendations and Communicate Results

Overview

Recommendations and Communication

- Recommendations for Reductions in Chemical Emissions and Levels
- Consideration of Types of Chemicals and Sources
- Communication of Results and Recommendations to Community

The final step of the Air Committee's work focused on the development of recommendations to improve air quality and the communication of the results of the Committee's work to the broader community. As discussed in the Introduction, work on these aspects of the screening exercise was significantly delayed when in the summer of 1998, following the completion of the final screening step, a key group of members left the Committee. Following this development, the Committee continued its work with input and direction from the Partnership's Executive Committee. At this point, the recruitment of new members became an additional goal for the Air Committee.

Recommendations for Acting on Results

Recommendations were developed to address the ambient air levels for the chemicals identified in the final screen.

Benzene in Wagners Point Resulting from Stationary and Area Source Emissions

The Committee recommended work to identify pollution prevention and risk management efforts to reduce emissions from the contributing facilities. Representatives of the bulk petroleum facilities were contacted and invited to participate in the work of the Air Committee. Company representatives and staff from the trade associations representing the companies agreed to participate and work to identify and implement opportunities to reduce emissions of benzene. In the spring of 1999, the residents of Wagners Point accepted a buyout offer unrelated to the work of the Air Committee and relocation of the community began. As a result, Committee work on the reduction of these benzene emissions was postponed.

Benzene and 1,3-Butadiene Levels Attributed to Mobile Sources

Based on its analysis, the Air Committee concluded that mobile sources contributed a significant portion of the levels of benzene and 1,3-butadiene in the Partnership neighborhoods. Toxics from mobile sources are both regional and national air problems and cannot be addressed solely in Partnership neighborhoods. As a result, the Air Committee recommended that the Partnership consider participating in air quality improvement efforts at the regional level. Both the MDE and EPA are considering new initiatives to control toxics from mobile sources and community input will be crucial to those efforts. The Air Committee made plans to invite representatives from MDE and EPA to speak to the Committee. The Committee will then develop a plan to make the community's voice heard on these issues.

Carbon Tetrachloride and Methyl Chloride

Recommendations were not developed for these chemicals based on the Committee's conclusion that their ambient levels were due to natural sources or past uses and not to any current use or emissions.

Given the limits of the study conducted by the Air Committee, which focused on emissions from industrial, commercial, and waste treatment and disposal facilities, the Committee also developed the following recommendations for additional work to address community concerns:

- Encourage appropriate actions to reduce odors;
- Encourage appropriate action to reduce diesel truck exhaust through means such as enforcement of current truck traffic restrictions, better diesel motor maintenance for vehicles regularly using local roads, and rerouting of truck traffic; and
- Develop ways to educate the community about the impacts of indoor air pollution.

Communication of the Results

The Air Committee made a major effort to find an effective way to communicate the results of its work to the broader community. Preparing a report to the community may have taken as much Committee work and time as conducting the technical screening exercise itself. The effort to effectively communicate the work of the Committee to the community began at the secondary screening step of the project. At that stage, several draft reports to explain the results of the secondary screen were prepared and discussed at length in the Committee. However, a consensus on the interpretation of the results did not develop, and the effort was halted as the results of the final screen became available.

With the results of the final screen and the recommendations in hand, the Committee began a new effort to develop a report for the public. At least 10 drafts were prepared. As a part of this process, the Committee brought together a group of residents not involved in the work to solicit their input on how to communicate the results of the screening exercise. Questions developed from this meeting were used to organize the report. The final Air Committee Report, approved in October 1999, can be seen in Appendix J.

Several factors contributed to the difficulties encountered in the effort to develop the public report. The work of the screening exercise was a new experience for all of the participants, including the technical staff working on the Committee. As a result, a considerable amount of time was spent learning about the process and its consequences. The task of summarizing the work in a public report brought all issues and questions to the surface, and building a consensus in the Committee on these issues required time and effort that could not be avoided. It was especially difficult to develop the understanding and explanation for exactly what the screening exercise could and could not accomplish. Understanding and explaining this required a review of all the data and methods used by the Committee. The Committee used an extensive peer review process to help it understand and clarify the issues raised in the report and to increase its confidence in the results. This process itself required time and effort. Explaining the relationship of the information provided in the exercise to the important questions of community health was especially difficult. In addition, some Committee members did not expect the results found in the screening exercise. The important discussion of the issues surrounding these expectations also added to the time required to summarize the work. The Committee also learned that it was not enough to summarize the results of its work, it also had to understand the community's views on the issues related to air quality and health. Learning this also took time. In all, the difficulty in drafting and finalizing the report was a reflection of the amount of educational work that was required to begin building a consensus on air quality issues in the community.

Despite all the work put into the public report found in Appendix J, the Committee recognized that it was still not adequate for broad dissemination in the community. While the Committee was convinced that it was an accurate description of its work and that the results were important information for the community, they recognized that it was still too long and technical for wide distribution. As a result, the Committee adopted a plan to present the information in the report to small groups in the community to get feedback on how to explain the screening exercise and its results. Plans were made to present the results to the local Ministerial Alliance, groups of local teachers, the chemical industry's Community Advisory Panel, Parent Teacher Association groups, a local tenants' association, and other small community groups. The Committee planned to prepare presentation, summary, and handout materials for these meetings based on the draft report. Committee presentations to small community groups are now starting. Using feedback from these meetings and its practice in preparing additional materials to explain the screening exercise and its results, the Committee plans to hold larger public meetings to disseminate the information throughout the community, as well as to recruit new members to address the issues recommended for additional work.

GENERAL OBSERVATIONS ON THE SCREENING METHODOLOGY DEVELOPED IN BALTIMORE

As explained in the introduction to this report, the screening method developed in the Partnership will undergo further development and trial. Plans are currently under way for two additional communities to use and improve this methodology. A peer review process for the methodology will also be undertaken both inside and outside the Agency. Using the experiences of the additional trials and the peer review, the screening methodology presented in this case study will be revised. The revised methodology will then be disseminated widely as a tool for community use.

Summary and Lessons Learned

- Methodology Was an Effective Screening Tool for Southern Baltimore
- Partnership Benefitted from Air Screening Exercise
- Technical Aspects of Screening Methodology Need Further Refinement

Preliminary conclusions based on the Baltimore experience indicate that the screening methodology developed in the case study and described in this report may have widespread application in communities concerned about air quality. This methodology could provide communities with an effective screening tool and with a process for building a community consensus on actions to improve air quality. Experiences in Baltimore also point out several key areas where this process can be improved. The observations and lessons learned, discussed below, will form the starting point for the further testing of the methodology.

The Methodology Provides an Effective Screening Tool for Communities

Local communities often have difficulty understanding environmental data and reaching consensus when setting priorities for effective community action. Communities are especially concerned about aggregate and cumulative exposures from the multiple sources in and around their communities. The screening methodology developed in Baltimore provides a technical tool to help communities begin to evaluate the potential impacts of sources of air pollutants in their neighborhoods and to quickly and effectively identify which chemicals might present higher than acceptable risk. The screening tool enables a community to go beyond the commonly available level of knowledge (of amounts and types of emissions) and to use information about the level of risk those chemicals might present. The methodology helps a community to combine emissions data, hazard information, exposure modeling, and risk screening in a priority-setting exercise. Moreover, the screening tool allows communities to begin to evaluate the aggregate exposure to single chemicals that have multiple sources in a local area and to consider cumulative effects by identifying multiple chemicals that have similar effects. The tool is designed to provide information in a relatively short time with limited resources. Use of the risk screening method allows communities to avoid the costly and time-consuming analysis of a full risk assessment,

while providing enough risk information to help a community build consensus on priorities for improving air quality.

Because the information provided by a risk screening analysis of this kind is limited, a special effort must be made to explain the uncertainties and limitations to the public. Without the proper level of educational effort, the risk screening tool could easily be misunderstood for a risk assessment, and conclusions could be mistakenly drawn that are not supported by the analysis. This is an inherent limitation of this risk screening analysis that must be taken into account. The narrow scope of the risk screening focuses on pollution sources to the ambient air, excluding other important areas of environmental risk in the community such as indoor air. It is important for the community to understand that the study on which this report is based examined only certain types of sources and only from the inhalation pathway. Other media (e.g., contaminated soil, drinking water, lead paint, etc.) and exposure routes should be taken into consideration. A special effort to place the screening results in a wider context of environmental risks is important to the proper use of this screening methodology, and may help avoid confusion and misplaced priorities.

The Methodology Helps Facilitate the Mobilization of Local Resources to Make Improvements in Local Air Quality

The results of the risk screening methodology used in Baltimore include more than technical facts about chemical risks that were determined using the screening tool. The methodology also incorporates a collaborative process that can result in better approaches to building community consensus and can mobilize community resources around concrete actions. These benefits come from the work that is required to build a partnership and to conduct the screening exercise. The Partnership attempts to bring all the sectors of the community together, including governments, and provides a forum for dialogue on air quality issues. It encourages the communication of information and perspectives among different sectors of the community and sets the stage for the development of a community consensus. The technical screening process itself provides a framework for the discussion of all the important air quality issues, as well as the relevant scientific methods that are involved. A thorough and careful discussion and understanding of hazard, exposure, modeling, and risk are essential to the success of the partnership approach. The methodology also emphasizes the need to ensure that all participants can participate fully in the process, maximizing the potential for consensus and for effective action. Overall, the methodology is designed to build the long-term ability of the community to understand and address air quality issues. As much as it is a technical screening tool, the methodology is also an educational process designed to make the best information and science available to the community.

Because the educational and capacity-building approaches are essential to this methodology, implementation requires the commitment of appropriate resources. The technical screening exercise can be done relatively quickly, but the accompanying education of both the Committee and the broader community will take time and resources. This process cannot be shortened if consensus and community mobilization are the goal of the process.

The Technical Aspects of Screening Methodology Need Further Refinement

- Addition of mobile source modeling. The Baltimore exercise focused on stationary and area sources. This task will expand capacity of methodology to include mobile source modeling.

- Review and improvement of source inventory review. Review existing source inventories to identify additional sources of emissions to ensure that all significant sources are included.

- Identification of best source for toxicity data. Compare available toxicity databases to identify most accessible and complete source of data for community screening exercise.

- Expansion of screening methodology to include short-term acute effects.

- Review of screening calculations to determine if they are appropriate for and protective of sensitive and urban populations.

- Development of a method to screen for cumulative exposures in the initial screening step.

- Expansion of methodology to include indoor air risks, to provide a more comprehensive picture of air risks.

- Incorporation of GIS mapping to enhance the communication of the modeling and screening results.

Specific Lessons Learned for Each Step of the Screening Methodology

<u>Step 1, Lessons Learned: Built Partnership, Clarified Goals, Developed Outreach Plan</u>

1. *Clarify Expectations About the Results of the Project from the Start*. It is important to clearly explain in detail what the project will and will not be able to accomplish. The limitations of the work must be completely understood, and the participants must agree that the results are worth the effort they will be making. Pay special attention to explaining that the information provided by the screening exercise will need to be combined with other information to effectively address public health concerns. Also, pay special attention to clarifying the difference between regulatory enforcement and voluntary pollution prevention actions.

2. *Clarify the Roles of All Participating Partners Before Starting*. While participants will need to be flexible to meet unforeseen circumstances, clarifying and agreeing on roles up front will

help communication. Participating governments should draft a Memorandum of Understanding (MOU) clearly outlining the known project tasks and responsibilities. The process of approving the MOU will give each participating government organization the opportunity to ensure that enough resources are assigned to the project. An MOU of some kind for all the partners may be helpful.

3. *Choose Government Staff Trained in Outreach and Community Work To Staff the Partnership Working Committee*. Technical staff who lack community outreach training should work with skilled community outreach staff. It is recommended that further training be provided to government staff on multimedia and other technical approaches relevant to community environmental concerns.

4. *Establish a Set of Minimum Partnership Representation Requirements That Need To Be in Place before Beginning a Project*. Make sure there are enough willing partners from each sector of the community who agree with the process and will work in a partnership with a broad range of stakeholders. All partners also must be committed and willing to work toward a consensus. Everyone will have personal agendas, but partners must be willing to work with others to try to find common ground. Representation from the different partners should be broad, reflecting as many community viewpoints as possible. Do not rely on a single group or organization to represent the community or businesses. If the minimum requirements cannot be met, it is better to postpone the project until broader participation can be developed, because the problems created down the road are likely to make the work ineffective.

5. *Resources Must Match the Capacity of the Community Where the Project Is Located*. If a strong community infrastructure with representation from all sectors of the community already exists, few resources will have to be devoted to building a partnership. Communities lacking strong civic infrastructures will require considerable time and resources to develop the necessary starting point for a successful project.

6. *Work on Trust-Building at the Start and Throughout the Project*. The partnership will bring together a broad representation of the community and governments. Trust will be an issue. This should be brought into the open and dealt with from the beginning. It will also reappear, especially when difficult issues or decisions must be made, so attention must be paid to building trust throughout the project.

7. *Establish Ground Rules That Reflect the Nature of the Partnership and Show Respect for the Process*. Discussion of these ground rules will provide the key ingredients for trust-building and the ability to complete work in an open and cooperative manner. Ground rules will provide an easy reference at difficult parts of the process.

8. *Get an Independent Facilitator for the Start-up Process and Working Meetings*. It is very important that someone skilled in facilitating partnerships be assigned to the group to pay

attention and to make sure the process is working. The facilitator should understand the content of the work but should be focused on process, making sure everyone participates equally, meetings are run and organized well, issues of trust are dealt with, etc. It is not possible to participate fully in the content of the working meetings and facilitate the process at the same time. Facilitators can be paid or volunteer and can be found locally, such as a local school principal or minister, or can come from outside the community from organizations such as the National Civic League.

9. *Set a Minimum Participation Level for Committee Legitimacy for Each Sector of the Community and Establish It As a Necessary Quorum for Meetings*. If the quorum is not met, then the committee should shift its emphasis to recruitment.

10. *From the Beginning of the Project, Identify Some Issues That Everyone Can Agree on and Organize Small Actions To Make Progress on These Issues*. Mixing action with screening work will help avoid the feeling some will have of never actually doing anything but meeting. It will also establish the Committee in the community and set the stage for better communication. The Committee can learn more through action and can recruit new members, if necessary. Taking action on asthma by setting up workshops through area Parent Teacher Associations (PTAs) is an example of an action that the Committee could adopt.

Step 2, Lessons Learned: Built Source Inventory Database

1. *Include the Means To Estimate or Collect Data on Emissions from Mobile Sources.* Mobile sources were not addressed in the Baltimore exercise primarily because the focus was on commercial, industrial, and waste treatment and disposal sources. Since mobile sources contribute significantly to air pollution, future efforts should consider modeling or measuring emissions from mobile sources.

2. *Investigate Existing Urban Source Inventories To Determine the Best Inventory To Use for the Screening Methodology*. The Baltimore methodology included point and area sources. Other sources may need to be added.

3. *Consider the Types of Emission Information Needed for the Screening Exercise As Soon As Possible After the Project Begins*. Information entered into a database from the onset of the process is much easier to handle and organize than hard copies of information that have to be physically manipulated.

4. *Set up a Personal Computer in a Central Location*. Having it set up in a community center or office will give all participants easy access to the data. Provide training on data entry and database use and maintenance. Investigate possibilities of accessing the database via Internet or other forms of live data sharing.

5. *Create Fields in the Source Inventory Database To Identify the Data Source for Each Entry, (e.g., from TRI or from the state permitting database*). This is especially useful for determining the most appropriate value when multiple values exist, and for quality control purposes.

6. *Routinely Update the Database*. Emission data and other information are likely to change over time. As new information becomes available, trained personnel should be available to periodically make the relevant changes.

7. *Use Residents, Local Industry, and Government Representatives as Valuable Resources To Verify the Location and Operational Status of Facilities*. A modest investment in equipment such as a geographic positioning system (GPS) unit, laser range finder, and U.S. Geological Survey (USGS) topo maps can significantly increase the accuracy of air modeling inputs such as facility location.

8. *Use State Air Toxics Studies Where Available*. These documents may contain valuable information that can be useful in conducting risk screening exercises such as data monitoring, emission estimates, facility information, and assessment methodologies.

9. *Save Significant Time and Effort by Designing Electronic Forms To Collect Various Types of Information*. These forms can be transferred via e-mail and should be designed to be compatible with the format of the emission inventory. In the case study, information on the facilities' stack parameters was collected by hand on hard copy forms and entered into the emission inventory database. Electronic forms would have allowed this information to be transferred directly into the database.

Step 3, Lessons Learned: Conducted Initial Screening

1. *Identify All the Key Decision Points in the Screening Exercise and Get Clear Committee Decisions on These Issues Before Starting the Exercise.* Focus especially on the decisions for choosing screening values and their relationship to the purpose of doing the screening exercise.

2. *Make a Special Effort To Provide the Necessary Background Information for Nontechnical Members of the Committee, Including Training, To Ensure That All Committee Members Fully Understand the Science of the Screening Process Prior to Step 3.* The screening meetings will be fairly technical and should be conducted with careful preparation and good facilitation. Such meetings should be held either by a subgroup that reports to the full Committee, or by the full Committee. These screening meetings should be open and residents should be encouraged to attend. Translation of the technical language (e.g., using outreach materials to make sure the community at large understands the process) should be provided for the nontechnical participants.

3. *Keep Detailed Records of the Decisions Made and the Reasons for the Decisions*. All steps of the screening process should be well documented for review by any interested community members.

4. *Be Thorough with the Review*. Given the level of detail and the amount of information, it would be better to hold two screening decision meetings. The first meeting should focus on identifying missing information and familiarizing each person with the process. The second and final decision meeting can then be more thorough and all points of view can be considered. Of critical importance is the gathering of toxicity information for the risk calculations. The database should be as complete as possible so the risk calculations can be made. This will ensure that all chemicals of concern to the community will be identified in the screening exercise.

5. *Develop and Carry Out a Quality Assurance Method To Ensure That No Inadvertent Errors Were Made in the Screening Exercise*. All data entries and calculations should be checked for accuracy. This quality control can be designed so that it does not cause too much of a delay in the work. Perhaps a local college or university can provide quality assurance as a class project.

6. *Prepare a Summary of the Decision Meeting(s) and Provide Outreach Materials to the Community Explaining the Decisions Immediately*. Keep the community informed as the screening process proceeds. This will start the information transfer to the community and give the Committee practice in explaining the process, strengths, and weaknesses.

7. *Review All the Assumptions of the Screening Process, Including the Generic Turner and ISC Modeling Methods to Determine if Adjustments Are Needed To Protect Children and Other Sensitive Populations in the Community*.

8. *Develop a Formal Method for Evaluating Potential Cumulative Exposures in the Initial Screening Step*. For the initial screening step, the Partnership Air Committee informally reviewed chemicals with multiple sources to determine if the combination of sources would reach the 10^{-6} cancer risk screening value.

9. *Try To Make Background Information and Training Available To Ensure That All Committee Members Fully Understand the Views of Each Member and the Science of the Screening Process Prior to Step 3.* This will take time, careful preparation, and good facilitation of Committee meetings. The Committee should summarize this exchange of information and prepare outreach materials to make sure the community at large has the benefit of this information.

10. *Develop a Common Interpretation of the Modeling Information and Communicate This Information to the Community at Each Stage/Step of the Process*. The screening process should not move forward until the Committee can reach agreement on any issues related to modeling and until community outreach materials are prepared.

Step 4, Lessons Learned: Conducted Secondary Screening

1. *At This Stage of the Screening Exercise, Avoid Using Actual Concentration Numbers in the Presentation of the Screening Results*. Using real numbers may create the impression that the screening analysis is more exact than warranted. The estimation of emissions and the uncertainties of the modeling used at this stage of the screening exercise are better expressed simply as "above" or "below" the screening level. The screening is designed to eliminate chemicals with some confidence, but those found to remain above the screening level need further information before any conclusions can be drawn about potential effects.

2. *Examine the Assumptions That Go into the Calculation of the Region 3 Risk-Based Concentration Tables (or other sources for risk-based concentrations).* Revisit assumptions for future screening exercises to ensure they are protective of sensitive populations and appropriate for urban ambient air screening.

3. *Develop and Review Further the Method for Grouping Chemicals wth Similar Effects To Estimate Cumulative Effects*.

4. *Keep Detailed Records and Check All Steps for Accuracy*.

Step 5, Lessons Learned: Conducted Final Screening

1. *Maintain Careful Record of the Information Provided by the Facilities in the Final Screen and Check for Accuracy*. A clear documentation of the differences between the secondary and final screenings will be important.

2. *If There Is a Monitoring Station In or Near the Project Area, Consider the Location of the Monitoring Station as One of the Model Outputs so Comparison of Monitored and Modeled Concentrations Can Be Facilitated.*

3. *If Possible, Verify Modeling Results with Monitoring for Validation.*

4. *Keep Detailed Records and Check All Steps for Accuracy.*

Step 6, Lessons Learned: Recommendations and Communication

1. *Engage the Committee in the Preparation of Communication Materials That Explain the Scope and Limits of the Exercise at the Beginning of the Process Before the Results Are In.* This will help everyone on the Committee to understand what will and will not come from the exercise. The early preparation of communication materials will also help to ensure that a gap does not exist between the time when the Committee gets the results of its screening exercise and the communication of those results to the community. This gap allows individuals to present their own interpretation of results to the community before the Committee has a chance to communicate the view of the Committee consensus.

2. *Establish Outreach Goals As a Core Committee Task.* The Committee should combine community outreach and information collection as equal goals. The Committee should devote approximately equal time to outreach and screening throughout the project.

3. *Develop Outreach Materials and Communicate to the Community at Each Stage of the Screening Process, Not Just at the End of the Exercise.* Communicate regularly to the community during the course of the screening exercise, perhaps in the form of a newsletter, press releases, and presentations to small community groups. This will develop the communication skills of the Committee and help to avoid the problem of having to learn how to communicate everything when the results come in. Meetings focused on screening and outreach should alternate, with the Committee providing constant updates and education on the work to the community. Please see the amended flow chart (Figure 7) for the screening methodology that incorporates this lesson. This flow chart presents community outreach and input, providing a more complete picture of the methodology than the flow chart presented in the Introduction.

4. *Communicate Regularly to the Press So They Understand the Process and Are Prepared To Help with Communication to the Public*.

5. *Present the Results of the Risk Screening in as Broad a Context as Possible so the Community Has the Information To Set the Most Effective Priorities*. Consider providing information on areas such as mobile sources and indoor air so that the community has as complete a picture of air risks as possible.

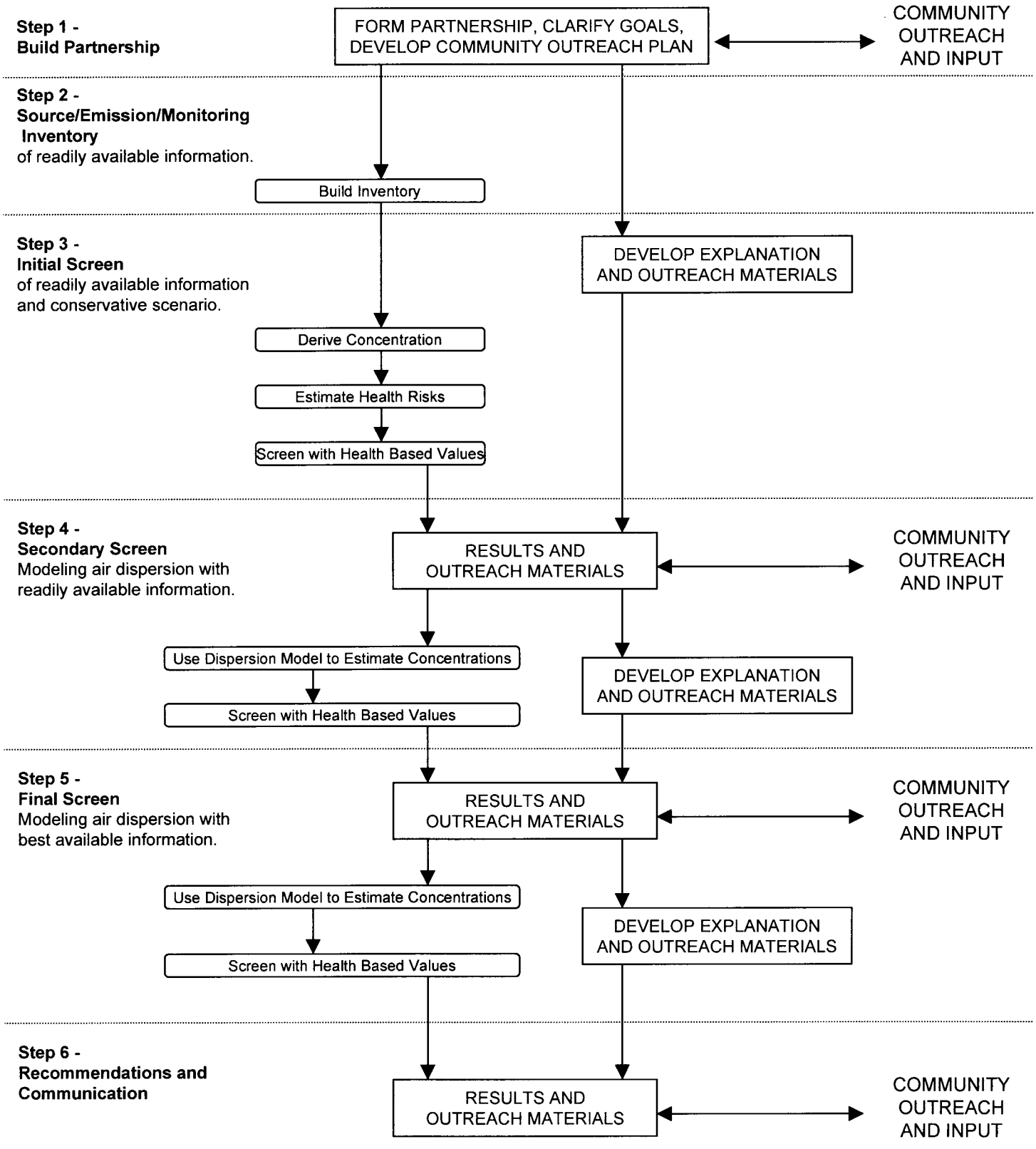


Figure 7. Generic Air Screening Methodology for the Community

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